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Process for dispersing dyestuff and silver halide photographic material containing dyestuff.

A process for the dispersion of a dyestuff represented by the following formula (I), which comprises the acceleration of molecular orientation in advance and/or during the dispersion and/or after the dispersion:

$D - (X)_y$ (I)

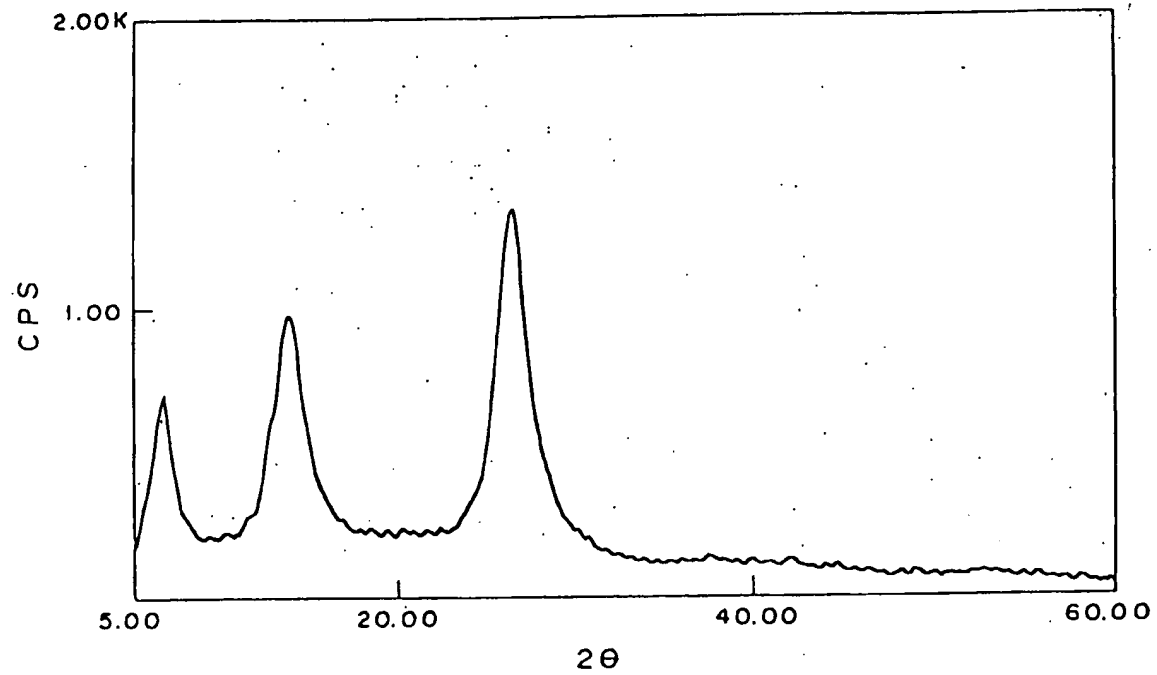
wherein the terms are as defined herein. In a preferred embodiment, formula (I) is represented by the following formula (II) and the acceleration of molecular orientation is carried out by heating:

$A_1 = (L_1 - L_2)_m = L_3 - (L_4 = L_5)_n - A_2$ (II)

wherein the terms are as defined herein and the heating may be effected in the presence of an organic compound containing carboxylic group. A silver halide photographic material, which comprises a dyestuff dispersed therein in accordance with the dispersion process as defined above, the dyestuff may be represented by formula (II), the ratio of the absorbance at 680 nm to that at 530 nm in the absorption spectrum of the dyestuff is 0.50 or less, and the ratio of the primary diffraction intensity when the diffraction angle 2θ of X-ray diffraction of the dyestuff is about 26 to 27 degrees to the secondary diffraction intensity when the diffraction angle 2θ is about 14 degrees may be 1.30 or less.

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Fig. 1



FIELD OF THE INVENTION

The present invention relates to a process for the dispersion of a dyestuff, particularly, a photographic filter dyestuff, more particularly an oxonol dyestuff. The present invention also relates to a silver halide photographic material comprising such a dispersion. More particularly, the present invention relates to a silver halide photographic material having a hydrophilic colloidal layer containing a dyestuff which can be easily incorporated and can be decolored and/or eluted in such a manner that it does not cause residual color after development.

BACKGROUND OF THE INVENTION

In the field of silver halide photographic materials, a light absorbing compound is generally incorporated into a silver halide emulsion layer or other hydrophilic colloidal layers to allow light of a specific wavelength range to be absorbed by these layers for the purpose of adjusting the sensitivity, the color temperature of light and the sensitivity balance in a multi-layer color light-sensitive material, enhancing the safelight stability or inhibiting halation.

For an example, a silver halide photographic material generally comprises hydrophilic colloidal layers such as light-sensitive silver halide emulsion layers. When a light-sensitive silver halide emulsion layer is imagewise exposed to light to form an image thereon, it is necessary to control the spectral composition of incident light upon the silver halide emulsion layer to improve the photographic sensitivity thereof. In this case, a dyestuff which is capable of absorbing light of wavelength ranges unnecessary for the light-sensitive silver halide emulsion layer is generally incorporated into a hydrophilic colloidal layer present farther from the support than the light-sensitive silver halide emulsion layer to make a filter layer by which only light of the desired wavelength range can be transmitted.

For the purpose of enhancing image sharpness, an antihalation layer is normally provided between the light-sensitive emulsion layer and the support or on the back side of the support to absorb harmful reflected light from the interface of the emulsion layer with the support or the back side of the support.

Further, for the purpose of enhancing the image sharpness, the silver halide emulsion layer may comprise a dyestuff capable of absorbing light of a wavelength range to which silver halide is sensitive to inhibit irradiation.

In particular, a silver halide photographic material for use in the photomechanical process, particularly a light-sensitive material for daylight use, comprises a dyestuff which absorbs ultraviolet light or visible light in a light-sensitive layer or a layer between the light source and the light-sensitive layer to enhance safelight safety.

In X-ray photographic light-sensitive materials, as a crossover cut filter for eliminating crossover light, a colored layer may be provided to enhance sharpness.

In microfilms, an antihalation layer provided between a light-sensitive emulsion layer and a support may also serve as a light-screening layer for the enhancement of daylight loadability.

These layers to be colored are often made of a hydrophilic colloid and thus normally comprise a dyestuff incorporated therein. Such a dyestuff needs to meet the following requirements:

- (1) proper spectral absorption according to the purpose;
- (2) photochemically inert (i.e., no adverse chemical effects on the properties of the silver halide photographic emulsion layer, e.g., sensitivity drop, regression of the latent image, fog);
- (3) decolorable at the photographic processing step but dissolvable, leaving no harmful coloring on the processed photographic light-sensitive material; and
- (4) excellent stability in a coating solution or silver halide photographic material and thus insusceptible to discoloration.

In order to find dyestuffs that meet these requirements, many efforts have been made.

If the layer comprising such a dyestuff serves as a filter layer or an antihalation layer, it is necessary that the layer be selectively colored so that other layers are not substantially colored. Otherwise, the layer not only exerts harmful spectral effects on the other layers but also loses its effects as a filter layer or antihalation layer.

As an approach for eliminating these difficulties, a method has been known which comprises localizing an acidic dyestuff containing sulfo group or carboxyl group in a specific layer with a mordant. Further, a method which comprises providing such a dyestuff in the form of a dispersed solid is disclosed in JP-A-56-12639 (the term "JP-A" as used herein means an unexamined published Japanese patent Application), JP-A-55-155350, JP-A-55-155351, JP-A-52-92716, JP-A-63-197943, JP-A-63-27838, and JP-A-64-40827, European Patents 0015601B1, and 0276566A1, and WO 88/04794.

However, most of these types of dyestuffs for use in the form of a dispersion utilize the dependence of the dissociation of a carboxyl group on the hydrogen ion concentration to control fixing and decoloration. Although such a dyestuff is substantially water-insoluble at a pH of 6 or less, it is disadvantageous in that it cannot be sufficiently fixed in a silver halide photographic material. Thus, the dyestuff diffuses into other layers, dissociates or dissolves during storage, or changes hue. It is known that if the dyestuff diffuses into other layers, it may exert adverse photographic effects such as filter desensitization and adsorption to silver halide grains on the light-sensitive material.

Such adverse photographic effects have been known to be exerted with oxonol dyestuffs, particularly, those disclosed in JP-A-52-92716, JP-A-55-120030, JP-A-63-27838, JP-A-64-40827, JP-A-2-277044, JP-A-2-282244, JP-A-3-23441, JP-A-3-208044, JP-A-3-192250, JP-A-3-194544, JP-A-3-200248, JP-A-3-204639, JP-A-3-204640, JP-A-3-206441, JP-A-3-206442, JP-A-3-208042, JP-A-3-208043, and JP-A-3-213847.

SUMMARY OF THE INVENTION

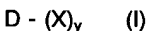
It is therefore an object of the present invention to provide a process for the dispersion of a solid fine dyestuff, for dyeing a specific hydrophilic colloidal layer in the photographic light-sensitive material and which exhibits excellent stability.

It is another object of the present invention to provide a silver halide photographic material which comprises a hydrophilic colloidal layer that can be exclusively dyed with a dyestuff and can be readily decolored upon photographic processing (particularly in low pH rapid processing).

It is a further object of the present invention to provide a silver halide photographic material with excellent storage stability which comprises a hydrophilic colloidal layer being dyed with a dyestuff that can be irreversibly decolored upon photographic processing.

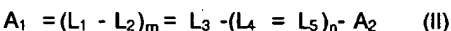
These and other objects of the present invention will become more apparent from the following detailed description and examples.

These objects of the present invention are accomplished by a process for the dispersion of a dyestuff represented by the following formula (I), which comprises accelerating molecular orientation in advance and/or during the dispersion and/or after the dispersion:



wherein D represents a compound containing chromophores; X represents a dissociative proton or dissociative proton-containing group connected to D directly or via a divalent connecting group; and y represents an integer of 1 to 7.

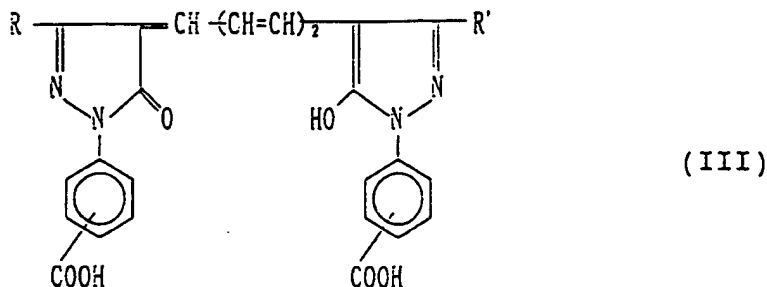
These objects of the present invention are also accomplished by a process for the dispersion of a dyestuff represented by the following formula (II), which comprises heating in advance and/or during the dispersion and/or after the dispersion:



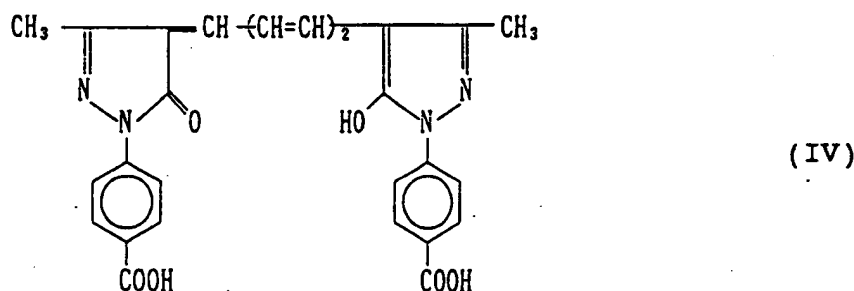
wherein A_1 and A_2 each represents an acidic nucleus necessary for the formation of an oxonol dyestuff; L_1 , L_2 , L_3 , L_4 and L_5 each represents a methine group; and m and n each represents 0 or 1.

These objects of the present invention are further accomplished by a dispersion process as defined above, wherein the heating is effected in the presence of an organic compound containing a carboxylic group with the dyestuff represented by formula (II).

Furthermore, it was found that these problems can be solved with a silver halide photographic material comprising on a support at least one light-sensitive silver halide emulsion layer and at least one hydrophilic colloidal layer containing a dispersed solid of a dyestuff represented by formula (II), wherein the ratio of the absorbance at 680 nm to that at 530 nm in the absorption spectrum of the dyestuff being in the range of 0.50 or less. Preferred among dyestuffs represented by formula (II) are those represented by the following formula (III):



wherein R and R' each represents an alkyl group, a substituted alkyl group, an aryl group, a substituted aryl group or an ester group. Furthermore, it has been found that these problems can be solved with a silver halide photographic material comprising on a support at least one light-sensitive silver halide emulsion layer and at least one hydrophilic colloidal layer containing a dispersed solid of a dyestuff represented by formula (II), wherein the ratio of the primary diffraction intensity when the diffraction angle 2θ of X-ray diffraction of said dyestuff is about 26 to 27 degrees to the secondary diffraction intensity when the diffraction angle 2θ is about 14 degrees is 1.30 or less. Particularly preferred among dyestuffs represented by formula (III) is one represented by the following formula (IV):



35 BRIEF DESCRIPTION OF THE DRAWINGS

By way of example and to make the description more clear, reference is made to the accompanying drawing in which:

- Figure 1 is a graph illustrating X-ray diffraction of Dyestuff IV-1;
 40 Figure 2 is a graph illustrating X-ray diffraction of Dyestuff IV-4, and
 Figure 3 illustrates the absorption spectrum of coat film Nos. 4-1 and 4-5, wherein 2θ indicates the diffraction angle; CPS indicates the diffraction intensity; A corresponds to coat film No. 4-1; and B corresponds to coat film No. 4-5.

45 DETAILED DESCRIPTION OF THE INVENTION

Formula (I) will be further described hereinafter.

The compound containing chromophores represented by D can be selected from many known dyestuff compounds. Examples of such compounds include oxonol dyestuffs, melocyanine dyestuffs, cyanine dyestuffs, arylidene dyestuffs, azomethine dyestuffs, triphenylmethane dyestuffs, azo dyestuffs, and anthraquinone dyestuffs. Specific examples of such dyestuffs include compounds as described in JP-A-3-259136, line 14, lower left column, page 5 - last line, lower left column, page 13.

The dissociative proton or dissociative proton-containing group contained in the dyestuff of the present invention represented by formula (I) is preferably in an undissociated form during dispersion and treatment for the acceleration of molecular orientation. Examples of such a group include a carboxylic group, a sulfonamide group, an arylsulfamoyl group, a sulfonylcarbonyl group, a carbonylsulfamoyl group, and an enol group in oxonol dyestuff.

Formula (II) will be further described hereinafter.

The acidic nucleus represented by A₁ or A₂ is preferably a methylene group or cyclic ketomethylene group interposed between electron withdrawing groups. Specific examples of such a methylene group or cyclic ketomethylene group will be given below in their keto form or analogous form.

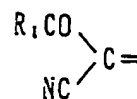
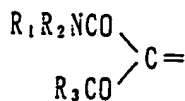
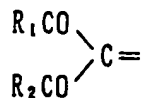
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A - 2

A - 3

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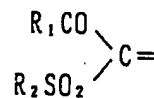
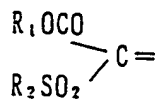
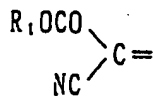
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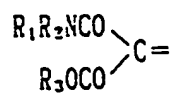
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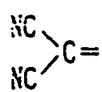
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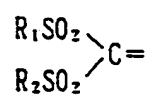
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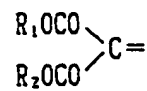
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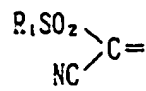
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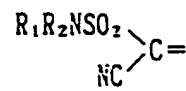
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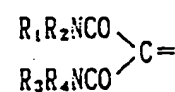
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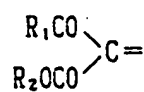
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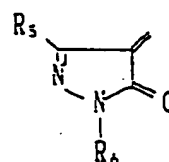
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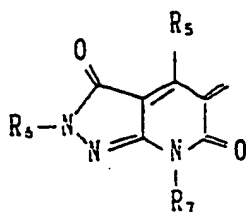
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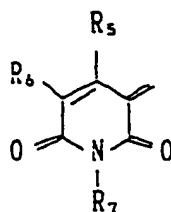
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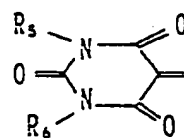
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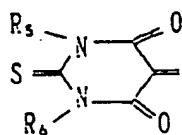
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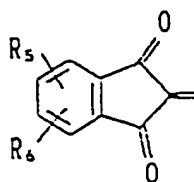
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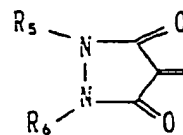
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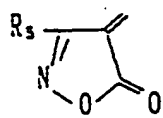
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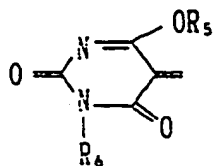
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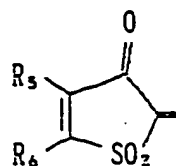
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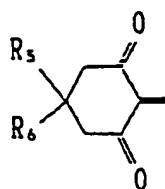
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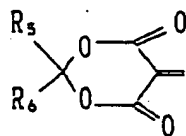
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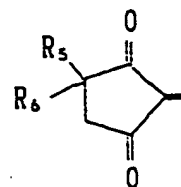
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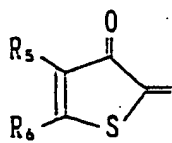
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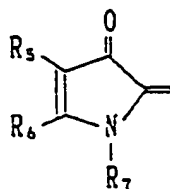
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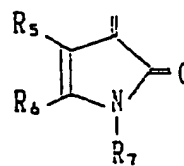
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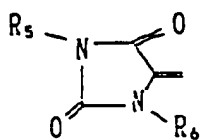
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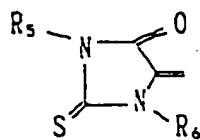
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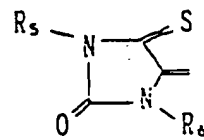
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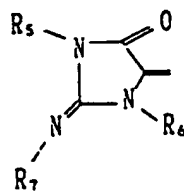
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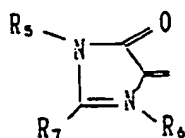
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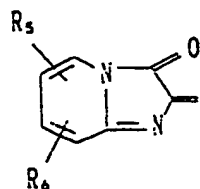
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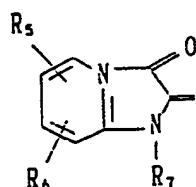


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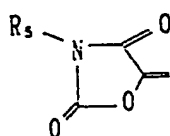
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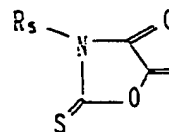
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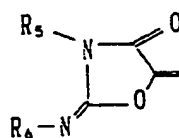


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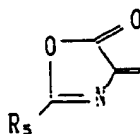
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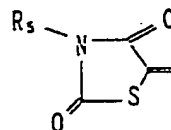
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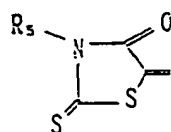
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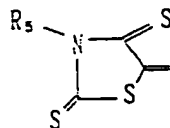
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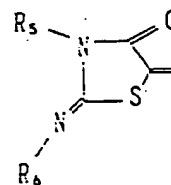
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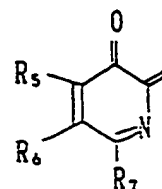
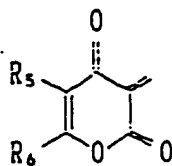
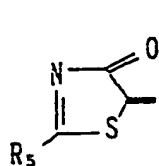


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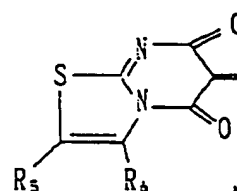
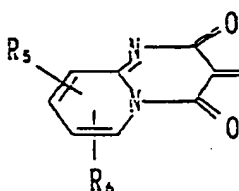
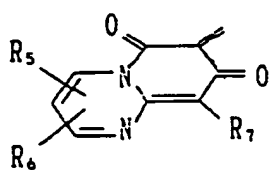
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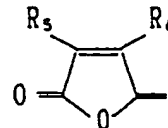
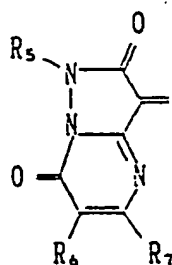
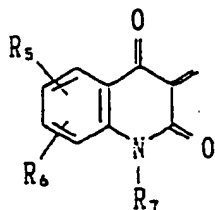
A-51



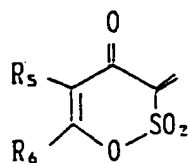
A-52

A-53

A-54



A-55



In these formulae, R_1 , R_2 , R_3 and R_4 each represents a hydroxyl group, an alkyl group, an aryl group, a heterocyclic group, or an alkenyl group, which may be substituted by substituent(s) which are those described for R_5 , R_6 and R_7 below. R_5 , R_6 and R_7 each represents a hydrogen atom or a substituent. R_1 and R_2 , R_3 and R_4 , or R_5 and R_6 may be connected to each other to form a 5- or 6-membered ring.

The substituent represented by R_5 , R_6 or R_7 is not specifically limited, provided it is not a substituent which substantially dissolves a dyestuff of formula (II) in water at pH 5 to 8. Examples of such a substituent include a carboxylic group, a C_{1-10} sulfonamide group (e.g., methanesulfonamide, benzenesulfonamide, butanesulfonamide), a C_{2-10} sulfonylcarbamoyl group (e.g., methanesulfonylcarbamoyl, propanesulfonylcarbamoyl), a C_{1-8} alkyl group (e.g., methyl, ethyl, isopropyl, butyl, hexyl, octyl, 2-hydroxyethyl, 4-carboxybutyl), a C_{1-8} alkoxy group (e.g., methoxy, ethoxy, butoxy), a halogen atom (e.g., chlorine, bromine, fluorine), C_{0-10} amino group (e.g., dimethylamino, diethylamino, carboxyethylamino), a C_{2-10} ester group (e.g., methoxycarbonyl), an amide group (e.g., acetylamino, benzamide), a C_{1-10} carbamoyl group (e.g., methylcarbamoyl, ethylcarbamoyl), a C_{0-10} sulfamoyl group (e.g., methylsulfamoyl, butylsulfamoyl, phenylsulfamoyl), a C_{6-10} aryl group (e.g., phenyl, naphthyl, 4-carboxyphenyl, 3-carboxyphenyl, 3,5-dicarboxyphenyl, 4-methanesulfonamidophenyl, 4-butanedisulfonamidophenyl), a C_{2-10} acyl group (e.g., acetyl, benzoyl, propanoyl), a C_{1-10} sulfonyl group (e.g., methanesulfonyl, benzenesulfonyl), a C_{1-10} ureide group (e.g., ureide, methylureide), a C_{2-10} urethane group (e.g., methoxycarbonylamino, ethoxycarbonylamino), a cyano group, a hydroxyl group, a nitro group, and a heterocyclic group (e.g., 5-carboxybenzoxazole ring, pyridine ring, sulfolane ring, furan ring).

The alkyl group represented by R_1 , R_2 , R_3 or R_4 is preferably a C_{1-10} alkyl group (e.g., methyl, ethyl, benzyl, phenethyl, propyl, butyl, isobutyl, pentyl, hexyl, octyl, nonyl) which may contain substituents (e.g., those described for R_5 - R_7 above).

The aryl group represented by R_1 , R_2 , R_3 or R_4 is preferably a C_{6-10} aryl group (e.g., phenyl, naphthyl) which may contain substituents (e.g., those described for R_5 - R_7 above).

The heterocyclic group represented by R_1 , R_2 , R_3 or R_4 is preferably a 5- or 6-membered heterocyclic group (e.g., oxazole ring, benzoxazole ring, thiazole ring, imidazole ring, pyridine ring, furan ring, thiophene ring, sulfolane ring, pyrazole ring, pyrrole ring, chroman ring, coumarine ring) which may contain substituents (e.g., those described for R_5 - R_7 above).

The alkenyl group represented by R_1 , R_2 , R_3 or R_4 is preferably a C_{2-10} alkenyl group (e.g., vinyl, allyl, 1-propenyl, 2-pentenyl, 1,3-butadienyl).

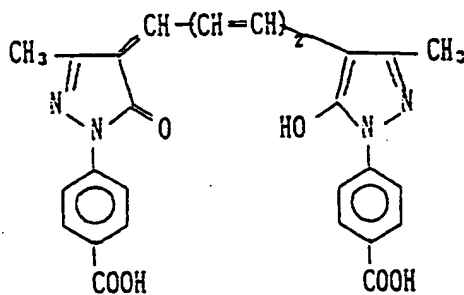
Examples of the 5- or 6-membered ring formed by connecting of R_1 to R_2 , R_3 to R_4 or R_5 to R_6 include a pyrrolidine ring, a piperidine ring, a morpholine ring, and a benzene ring.

The methine group represented by L_1 , L_2 , L_3 , L_4 or L_5 may contain substituents (e.g., methyl, ethyl). These substituents may be connected to each other to form a 5- or 6-membered ring (e.g., cyclopentene ring, cyclohexene ring, isophorone ring). However, the methine group is preferably unsubstituted.

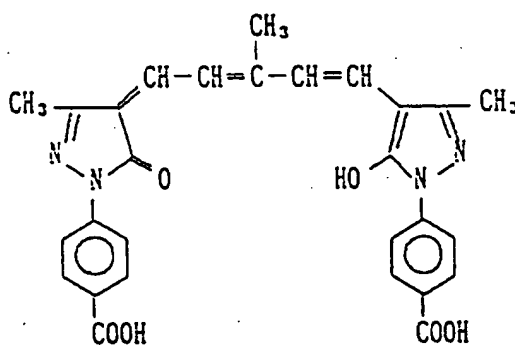
In formula (II), at least one of A_1 and A_2 is preferably a pyrazolone nucleus. More preferably, A_1 and A_2 each represents a pyrazolone nucleus, and m and n each represents an integer of 1. Even more preferably, A_1 and A_2 each represents a pyrazolone nucleus, m and n each represents an integer of 1, and at least one carboxylic group or sulfonamide group is contained in formula (II).

Specific examples of the dyestuff represented by formula (II) will be given below, but the present invention should not be construed as being limited thereto.

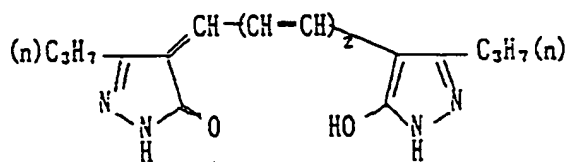
I - 1 (Dyestuff (IV))



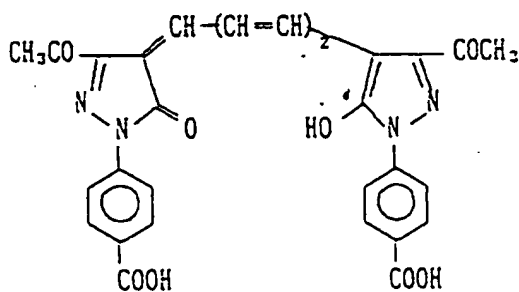
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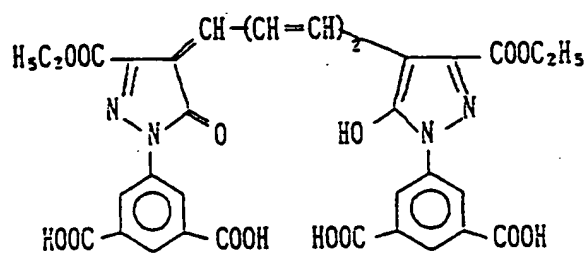
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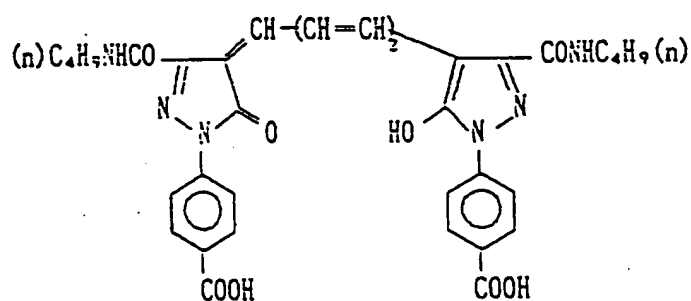
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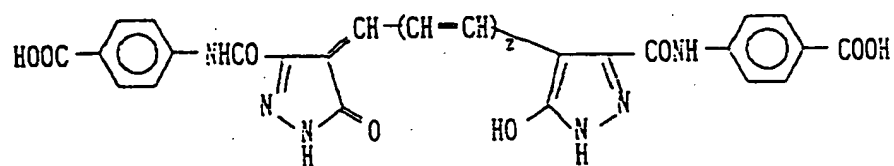
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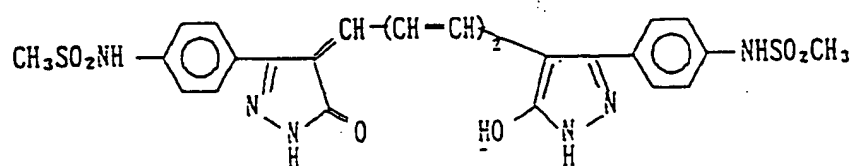
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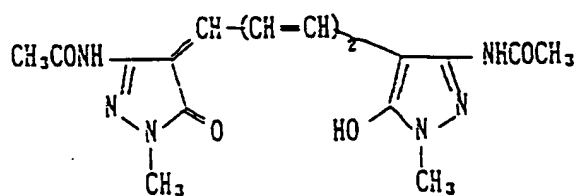
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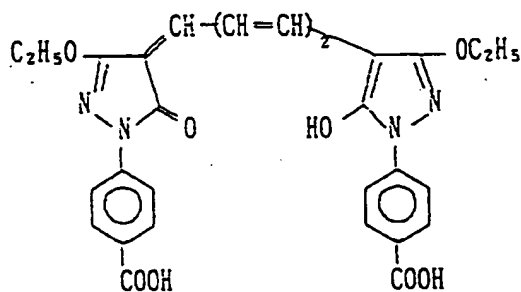
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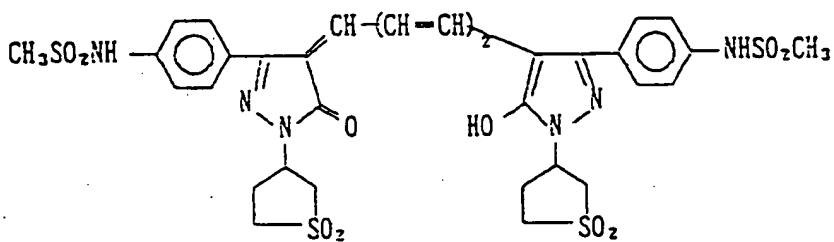
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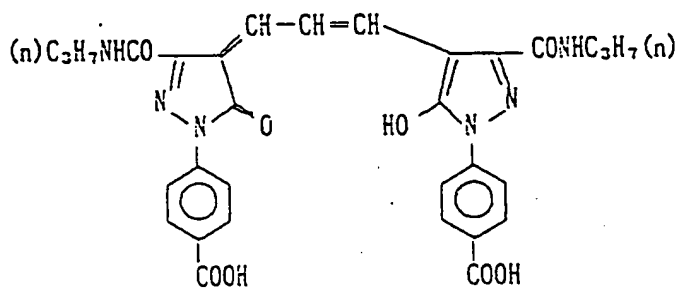
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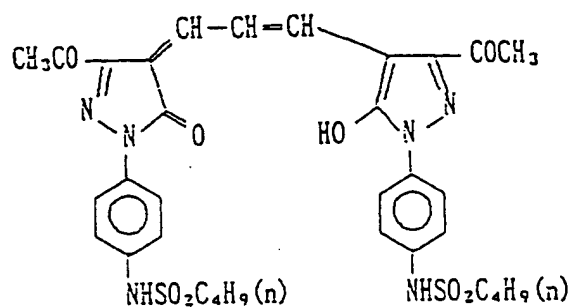
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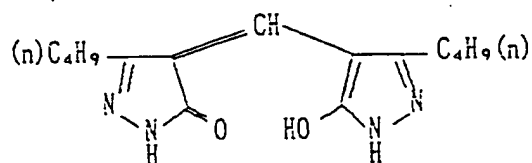
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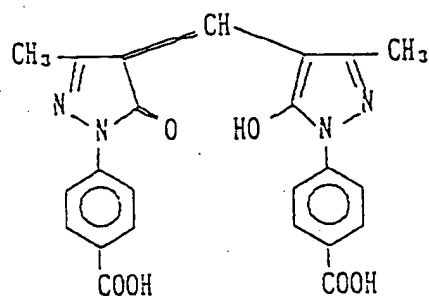
I - 1 3



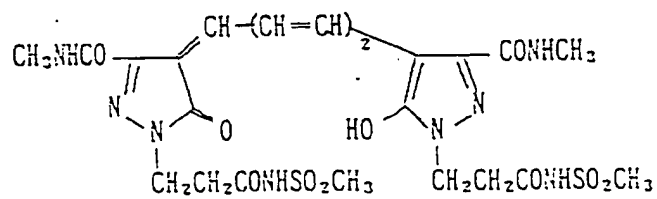
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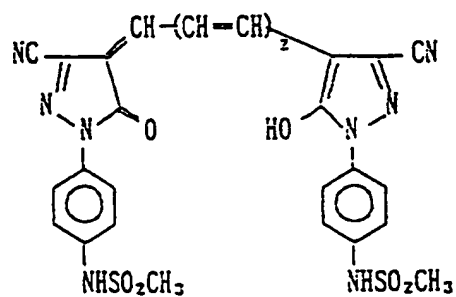
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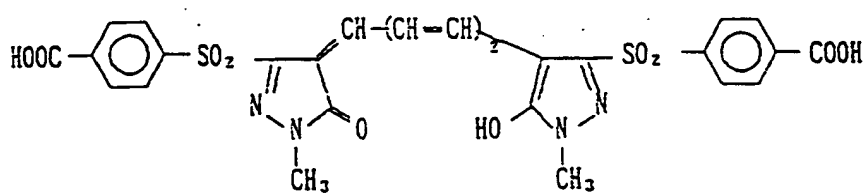
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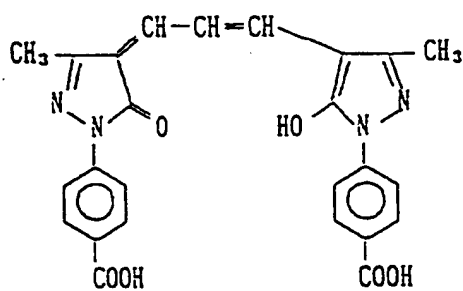
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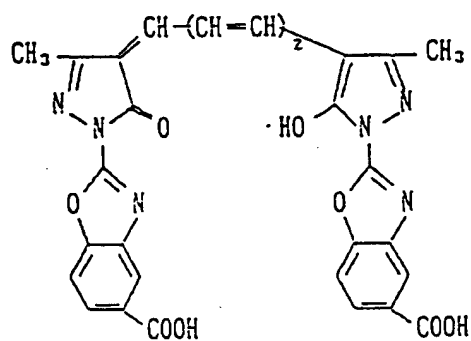
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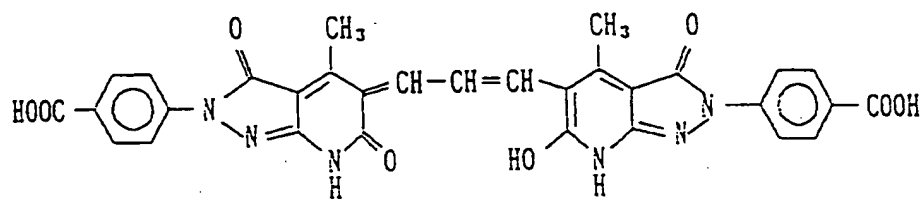
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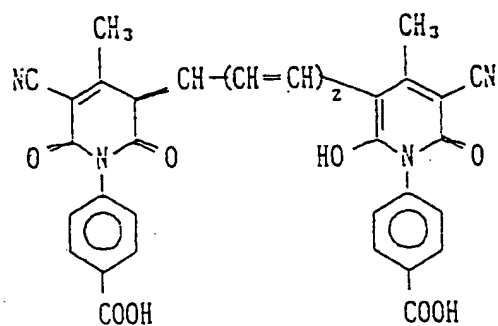
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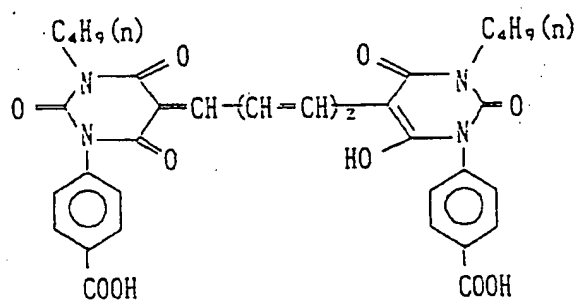
I - 2 1



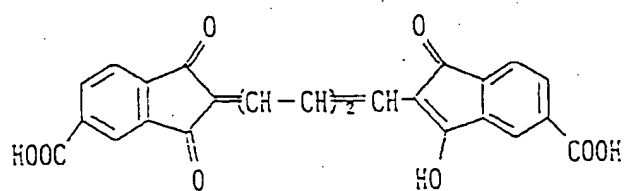
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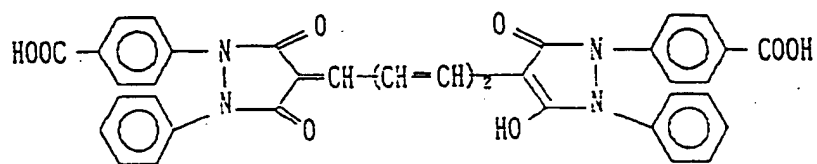
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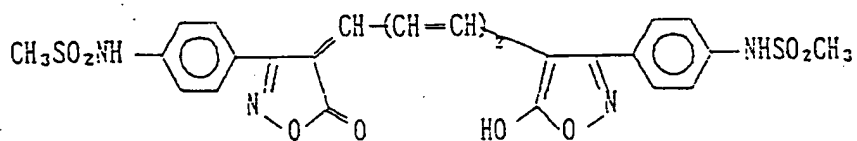
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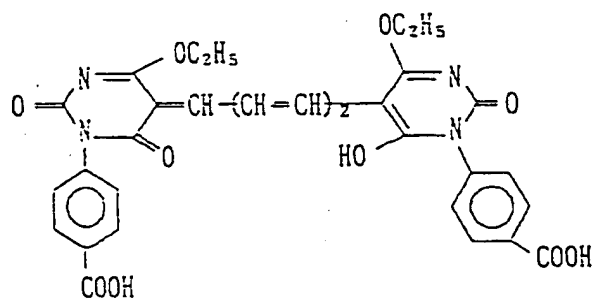
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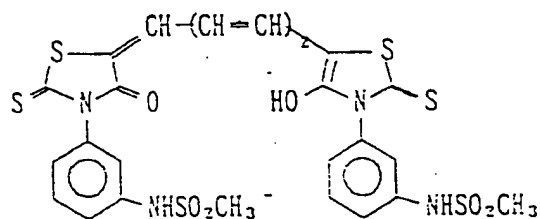
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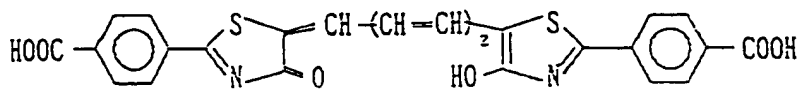
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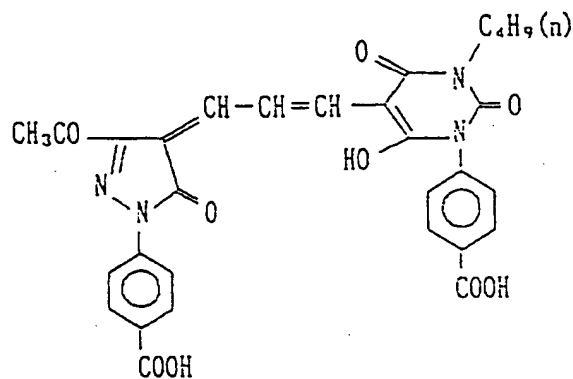
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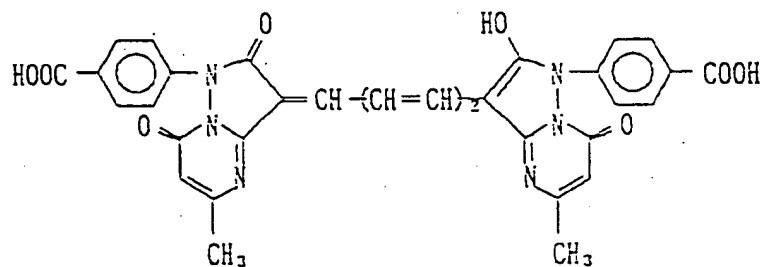
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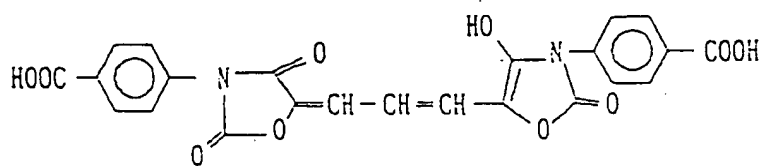
I - 3 0



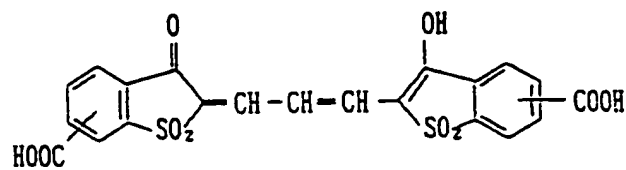
I - 3 1



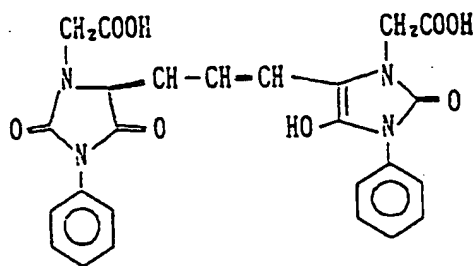
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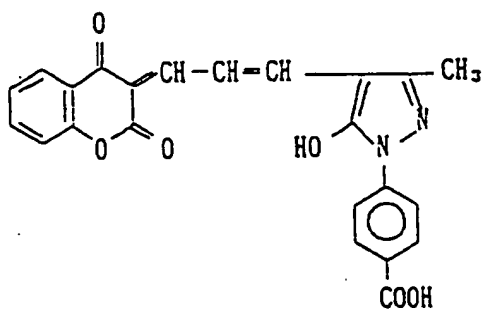
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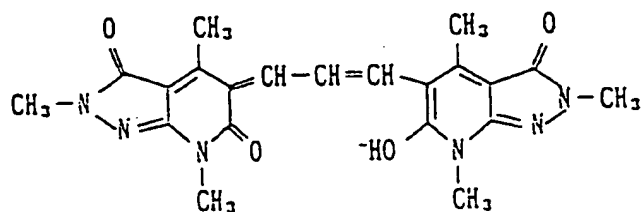
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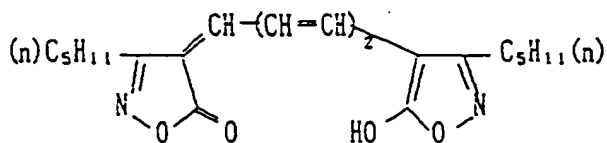
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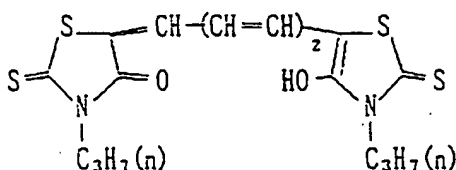
I - 3 6



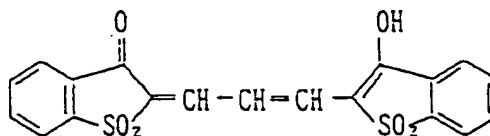
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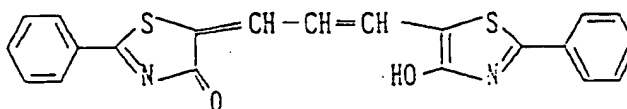
I - 3 8



I - 3 9



I - 4 0



The synthesis of dyestuffs represented by formula (II) can be accomplished by methods known to those skilled in the art (e.g., condensation reaction of the corresponding acidic nucleus with a methine source such as ethyl orthoformate, diphenylamidine, 1,1,3,3-tetramethoxypropane, malonaldehydedianil and glutaconaldehydedianil). Specifically, methods described in JP-A-52-92716, 55-120030, 63-27838, 64-40827, 2-277044, 2-282244, 3-23441, 3-208044, 3-192250, 3-194544, 3-200248, 3-204639, 3-204640, 3-206441, 3-206442, 3-208042, 3-208043, and 3-213847 can be used.

The means for the dispersion of the dyestuff in the present invention can be freely selected from various dispersing machines such as a ball mill, a sand mill and a colloid mill (as described in JP-A-52-92716 and WO 88/04794), an oscillating mill, a planetary ball mill, a jet mill, a roll mill, a mantongauline, a microfluidizer and a disc impeller mill. The vertical or horizontal medium dispersing machines such as a sand mill are preferably used.

In these processes, a solvent (e.g., water) is preferably used and the combination of a solvent and a dispersing surface active agent is more preferably used.

Examples of the dispersing surface active agent include an anionic surface active agent as described in JP-A-52-92716, and WO 88/04794 or an anionic polymer as described in Japanese Patent Application No. 3-121749 or a nonionic or cationic surface active agent as necessary. An anionic polymer or anionic surface active agent is preferred.

5 A poor solvent may be added to a solution of a dyestuff of the present invention in a proper solvent for the dyestuff of the present invention to precipitate microcrystalline products. In this case, the above-mentioned dispersing surface active agent may be used. Alternatively, microcrystallization may be carried out by controlling the pH value of the system to dissolve the dyestuff, and then changing the pH value of the solution.

10 The finely divided grains of dyestuffs in the dispersion generally have an average grain diameter of 0.005 to 10 μm , preferably 0.01 to 1 μm , more preferably 0.01 to 0.5 μm , optionally 0.01 to 0.1 μm .

The acceleration of molecular orientation, which means increasing regularity in orientation of dyestuff molecules, of the dyestuff of formula (I) or (II) can be effectively accomplished by heat treatment, ultrasonic treatment, mechanical treatment, high frequency treatment, etc., particularly preferably in a wet state or in a solvent. Particularly preferred among these treatments are heat treatment and high frequency treatment. 15 The heat treatment of the dyestuff of formula (I) or (II) is preferably effected before and/or after dispersion. In order to conduct the heat treatment of the dyestuff of formula (I) or (II) more effectively, it is preferably conducted at least after dispersion.

Examples of such a heat treatment process include (1) a method which comprises heat treatment at a time prior to fine solid dispersion, (e.g., heat treatment at a drying step after the synthesis of a dyestuff or heating of a dyestuff powder in a solvent), (2) a method which comprises dispersion of a dyestuff in water or other solvents in the presence of a dispersant without cooling or at an elevated temperature, and (3) a method which comprises heat treatment of a solution or coating solution in which a dyestuff has been dispersed.

25 The heat treatment temperature depends on the heat treatment step, the size and shape of powder or grain, the heat treatment conditions, solvent used, etc. and can be readily determined by the artisan. The heat treatment temperature is preferably from 40 °C up to the highest temperature at which the dyestuff is not decomposed. If the dyestuff is heat-treated in the form of powder, the heat treatment temperature is preferably from 40 °C to 250 °C, more preferably 50 °C to 150 °C. If the dyestuff is heat-treated in a solvent, the heat treatment temperature is preferably from 40 °C to 150 °C, more preferably 50 °C to 150 °C. If the dyestuff is heat-treated during dispersion, the heat treatment temperature is preferably from 40 °C to 90 °C, more preferably 50 °C to 90 °C. If the dyestuff is heat-treated in the form of dispersion, the heat treatment temperature is preferably from 40 °C to 100 °C, more preferably 50 °C to 95 °C.

In order to conduct the heat treatment effectively, it is preferably conducted in a solvent. The kind of solvent is not specifically limited provided it does not substantially dissolve a dye of formula (I) therein. 35 Examples of such a solvent include water, alcohol (e.g., methanol, ethanol, isopropyl alcohol, butanol, isoamyl alcohol, octanol, ethylene glycol, diethylene glycol, ethyl cellosolve), ketone (e.g., acetone, methyl ethyl ketone), ester (e.g., ethyl acetate, butyl acetate), alkylcarboxylic acid (e.g., acetic acid, propionic acid), nitrile (e.g., acetonitrile), and ether (e.g., dimethoxyethane, dioxane, tetrahydrofuran).

40 If an organic carboxylic acid is present in the system during the heat treatment, the objects of the present invention can be more effectively accomplished. Examples of such an organic carboxylic acid include alkylcarboxylic acid (e.g., acetic acid, propionic acid), carboxymethyl cellulose (CMC), and arylcarboxylic acid (e.g., benzoic acid, salicylic acid).

The amount of such an organic carboxylic acid to be used as a solvent is preferably 0.5 to 100 times 45 the weight of the dye of formula (I). If such an organic carboxylic acid is added to the system in a solvent other than organic carboxylic acid, its amount may be in the range of 0.05 to 100 % by weight based on the weight of the dye of formula (I).

The heat treatment time varies depending on conditions, but can be appropriately selected by the artisan. The lower the heat treatment temperature, the longer is the heat treatment time required. The higher 50 the heat treatment temperature, the shorter is the heat treatment time required. The heat treatment time can be freely predetermined such that the desired heat treatment can be realized without affecting the manufacturing process. The heat treatment time is typically 15 minutes to 3 weeks, preferably 1 hour to 10 days, more preferably 1 hour to 4 days.

The dyestuffs represented by formula (III) to be used in the present invention have been described in 55 JP-A-52-92716, JP-A-2-264936, JP-A-3-238447 and JP-A-4-125635, and many other patents.

In the absorption spectrum of the dyestuff of formula (IV), as described in JP-A-52-92716, a solid dispersion of a dyestuff of formula (IV), obtained by a known synthesis method, exhibits a high absorption in the vicinity of 680 nm. Such a dyestuff can be easily dissociated and diffuse into other layers in a

photographic light-sensitive material under certain temperature and relative humidity conditions. Such a dyestuff exhibits a relatively high absorption in the vicinity of 680 nm in the photographic light-sensitive material in which it is typically incorporated.

None of the above mentioned patents or other patents describe that such a dyestuff exhibits a low absorption spectrum in the vicinity of 680 nm. In general, it can be considered that the spectral pattern described in JP-A-52-92716 can be obtained. The agglomerate which has been left undissociated exhibits a considerably broad spectral absorption in the vicinity of 530 nm. The lower the absorption intensity in the vicinity of 680 nm is relative to that in the vicinity of 530 nm, the less the change in the spectral absorption under some temperature and relative humidity conditions is. The lower adsorption intensity in the vicinity of 680 nm relative to that in the vicinity of 530 nm is preferred. In the present invention, the ratio of the absorbance at 680 nm to that at 530 nm is preferably 0.50 or less, more preferably 0.40 or less, with the lower limit preferably being 0.01.

The measurement of X-ray diffraction of the dyestuff of formula (IV) suggests that the dyestuff has a molecular orientation repeated only in a one-dimensional direction and thus is a layered compound. In the X-ray diffraction pattern, a primary diffraction peak is observed at a diffraction angle 2θ of about 26 to 27 degrees, which corresponds to an interfacial spacing of about 3.3 Å, and higher order diffraction peaks based on this primary diffraction peak are observed. It was found in the X-ray diffraction pattern of the dye of formula (IV), prepared by the above mentioned known synthesis method, that the intensity of primary diffraction peak at a diffraction angle 2θ of about 26 to 27 degrees is considerably higher than that of secondary diffraction peak at a diffraction angle 2θ of about 14 degrees. This shows that the dye of formula (IV) according to the present invention exhibits a relatively high secondary diffraction peak intensity and thus has sharper peaks. It can be interpreted that the dyestuff of formula (IV) according to the present invention has a higher regularity of molecular orientation. In the present invention, the ratio of the intensity of primary diffraction at a diffraction angle 2θ of about 26 to 27 degree to that of secondary diffraction at a diffraction angle 2θ of about 14 degrees is 1.30 or less, preferably 1.20 or less, with the lower limit preferably being 0.1.

Some relationship can be observed between the above mentioned diffraction intensity ratio and the previously mentioned absorbance ratio in the absorption spectrum. The smaller the diffraction intensity ratio is, the smaller is the absorbance ratio and hence the smaller is the change in the absorption spectrum due to heat and moisture. However, this tendency is not necessarily true because different dispersants, dispersing machines and other dispersing conditions under which the solid dispersion is prepared may give different absorption spectra with the same X-ray diffraction pattern.

The dyestuff according to the present invention can be subjected to the previously mentioned acceleration of molecular orientation before being incorporated in the light-sensitive material to provide the desired absorption spectrum and/or X-ray diffraction pattern of the present invention.

The dyestuff of the present invention may be incorporated in a hydrophilic colloidal layer in the form of fine solid dispersion for various purposes. The position at which the dyestuff of the present invention is incorporated depends on the purpose and can be readily determined by the skilled artisan. The dyestuff of the present invention can be provided between a support and a silver halide emulsion layer to serve as an antihalation layer, crossover cut layer or layer for screening light from the back side (i.e., shielding layer). Alternatively, the dyestuff of the present invention can be incorporated in the silver halide emulsion layer to inhibit irradiation. Further, the dyestuff of the present invention can be provided above the silver halide emulsion layer (outside the silver halide emulsion layer with respect to the support) to serve as a filter layer, particularly a safelight filter layer.

The amount of the dyestuff of the present invention to be coated in the hydrophilic colloidal layer in the form of solid fine dispersion depends on the kind of the dyestuff, the absorbance required, etc. and can be readily determined by the skilled artisan. The amount of dyestuff is typically from 1 mg/m² to 300 mg/m², preferably 3 mg/m² to 200 mg/m² per one layer containing dyestuff.

As the hydrophilic colloid, gelatin can be preferably used. The dyestuff of the present invention can be incorporated in a color photographic light-sensitive material as well as a black-and-white photographic light-sensitive material. Therefore, the desired coated amount of gelatin vary. The amount of gelatin to be coated on the same side of the support as the side containing the dyestuff dispersion is generally from 1.5 g/m² to 30 g/m², preferably 1.5 g/m² to 20 g/m². The content of gelatin in the layer containing the dyestuff dispersion is preferably 20 mg/m² to 3 g/m². Particularly from the standpoint of expedited processing, the coated amount of hydrophilic colloid is preferably minimized. In a preferred embodiment, the layer containing a dyestuff dispersion may be a subbing layer provided between the support and the silver halide emulsion layer, wherein the coated amount of hydrophilic colloid in the subbing layer is generally 0.5 g/m² or less, preferably 20 mg/m² to 300 mg/m².

The silver halide photographic light-sensitive material of the present invention may be a double-sided light-sensitive material.

Various kinds of gelatins have been known. In the present invention, suitable examples include lime-treated gelatin, acid-treated gelatin or various modified gelatins.

5 The solid fine dispersion of the dyestuff of the present invention can be incorporated, singly or in combination with other solid fine dispersion, in the photographic light-sensitive material as a dyestuff. The solid fine dispersion of the dyestuff of the present invention can be incorporated in the same layer as, or different layers from, a layer containing other solid fine dyestuff dispersions. By way of example, a mixture of a dyestuff dispersion of the present invention with a solid fine dispersion of a yellow dyestuff absorbing
10 light of a shorter wavelength than the dyestuff dispersion of the present invention may be used as an antihalation layer. Alternatively, a mixture of a dyestuff dispersion of the present invention with a solid fine dispersion of an infrared dyestuff absorbing light of a longer wavelength than the dyestuff dispersion of the present invention may be used as an antihalation layer. Further, a dyestuff dispersion of the present invention may be used as an antihalation layer while a solid fine dispersion of a yellow dyestuff absorbing
15 light of a shorter wavelength than the dyestuff dispersion of the present invention may be used as a filter layer.

Dispersible solid dyestuffs which can be used in combination with a dyestuff dispersion of the present invention are further described in WO 88/04794, JP-A-4-14033 and Japanese Patent Application No. 3-121749. Any of these dispersible solid dyestuffs can be used.

20 A solid fine dispersion of, for example, a dyestuff of the present invention can be incorporated in two or more layers. The dyestuff dispersion of the present invention is fixed in a specific layer. For example, the dyestuff of the present invention may be incorporated in an amount required as an antihalation layer, and then incorporated in the silver halide emulsion layer in an amount required for the inhibition of irradiation.

Known water-soluble dyestuffs can be used in combination with the dyestuff of the present invention, as
25 necessary. Further, an oil-soluble dyestuff can be used in the form of an emulsion dispersion or polymer dispersion in combination with the dyestuff of the present invention, as necessary.

On development, the solid dispersion of dyestuff of the present invention mainly decomposes and elutes with hydroquinone, sulfite or alkali in the developer, causing no coloring or staining in the photographic image. The time required for decoloration greatly depends on the concentration of
30 hydroquinone and the content of sulfite, alkali or other nucleophilic reagent in the developer or other processing baths, the kind, amount and position of incorporation of the compound of the present invention, the amount and swelling of the hydrophilic colloid, the extent of agitation, etc. and thus cannot be unequivocally defined. The time required for decoloration can be arbitrarily controlled according to general principles of physical chemistry.

35 The pH value of the processing solution depends on the kind of processing, i.e., development, bleach or fixing, and is preferably 3.0 to 13.0, more preferably 5.0 to 12.5. Thus, the compound of the present invention has a dyestuff unit which can be released with a processing solution having such a low pH value.

In the photographic light-sensitive material comprising the light-sensitive silver halide emulsion layer used in the present invention, light-sensitive materials commonly used in the art can be employed, and
40 silver halide emulsions commonly used in the art can similarly be employed. For example, light-sensitive materials and silver halide emulsions as described in JP-A-3-13936 and JP-A-3-13937 can be used. More particularly, silver halide emulsions, light-sensitive materials containing such silver halide emulsions, supports therefor, and processing methods and exposure methods thereof described in JP-A-3-13936, line 8, lower right column, page 8 - line 9, upper left column, page 15, can be similarly employed in the present
45 invention.

The present invention will be further described in the following examples, but the present invention should not be construed as being limited thereto. Percentages are by weight unless otherwise indicated.

EXAMPLE 1

(1) Synthesis of Dyestuff I-1

50 To a mixture of 26.2 g of 1-(4-carboxyphenyl)-3-methyl-2-pyrazoline-5-one, 14.2 g of glutacanal-dehydedianyl hydrochloride and 200 ml of N,N-dimethylformamide was added 30.3 g of triethylamine. The
55 mixture was then stirred at room temperature for 1 hour. To the reaction solution was added 100 ml of methanol. The reaction solution was then subjected to dust removal by filtration. To the reaction solution was added dropwise a methanol solution of hydrochloric acid (mixture of 53 ml of a 36 % concentrated hydrochloric acid and 80 ml of methanol) with stirring at a temperature of 20 °C to 25 °C in 15 minutes.

After the dropwise addition, the reaction system was further stirred at the same temperature for 30 minutes. The reaction product was filtered off with suction, and then washed with 200 ml of methanol three times. The material was then washed with water until the filtrate became neutral. Thus, 83 g of Dyestuff I-1 in wet state (hereinafter referred to as "I-1-A") was obtained (content of Dyestuff I-1: 28.5 %).

5

(2) Heat treatment

i. Drying (without heating; comparative)

10 60 g of I-1-A was dried by air blow for 1 week. After dried, the material weighed 17.1 g. The dried material will be hereinafter referred to as "I-1-B".

ii. Heat drying

15 60 g of Dyestuff I-1-A was heat-dried at a temperature of 60 °C to 70 °C at normal pressure for three days. After dried, the material weighed 17.1 g. The dried material will be hereinafter referred to as "I-1-C".

iii. Heat treatment in solvent

20 To 10 g of Dyestuff I-1-B was added 60 ml of water. The material was then heated under reflux with stirring. The material was cooled to room temperature. The resulting solid content was then filtered off with suction. Thus, 25 g of Dyestuff I-1 was obtained in wet state (content of Dyestuff I-1: 40 %). This product will be hereinafter referred to as "I-1-D".

25 iv. Heat treatment in the presence of carboxymethyl cellulose

To 10 g of Dyestuff I-1-B was added 100 ml of a 1 % aqueous solution of carboxymethyl cellulose. The material was then heated under reflux for 8 hours. The aqueous suspension was then cooled to room temperature. This product will be hereinafter referred to as "I-1-E".

30

v. Heat treatment in acetic acid

To 10 g of Dyestuff I-1-B was added 40 ml of acetic acid. The material was then heated at a temperature of 105 °C to 110 °C with stirring for 7 hours. The material was cooled to room temperature. 35 The resulting solid content was filtered off with suction. The solid content thus obtained was washed with 100 ml of methanol once and then with 50 ml of water four times. Thus, 18 g of heat-treated Dyestuff I-1 in wet state (content of Dyestuff I-1: 55.6 %) was obtained. This product will be hereinafter referred to as "I-1-F".

40 (3) Dispersion

Dyestuffs I-1-A to I-1-F thus obtained were dispersed by the method described below. However, for those which had already contained water or carboxymethyl cellulose (e.g., A, D, E, F), the amount of water or carboxymethyl cellulose was adjusted to obtain the predetermined value.

45 To 3.75 g (calculated in terms of solid content) of Dyestuff I-1 was added 37.5 ml of a 1 % aqueous solution of carboxymethyl cellulose as a dispersant to obtain a premix. To the premix was added 53.7 ml of water. The material was then subjected to dispersion with zirconia beads by means of a horizontal medium dispersing machine (Eiger Motor Mill M-50, manufactured by Eiger Japan Co. Ltd.) for 3 hours. The zirconia beads were removed by filtration. The dispersion was diluted with water until the dyestuff concentration 50 reached 2 %.

(4) Evaluation of photographic properties

i. Preparation of specimen

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A silver halide photographic material was prepared in accordance with the method described in JP-A-3-249752, line 7, upper left column, page 24 - line 20, lower left column, page 25. However, Dyestuff I-1 of the present invention in the form of a dispersion formed by the above mentioned method was used instead

of Dyestuff I-1 described in JP-A-3-249752, line 18, upper right column, page 24, in an amount of 120 mg/m² as calculated in terms of Dyestuff I-1.

ii. Evaluation of storage stability

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The specimen thus obtained was then stored at a temperature of 40 °C and 80 % RH for 3 days. The specimen was then subjected to the processing set forth in the table in JP-A-3-249752, line 8, lower right column, page 25 - upper left column, page 26. The sensitivity difference was then determined from the specimen which had not been stored as calculated as desensitization degree. The results are set forth in

10 Table 1.

Table 1

15

Specimen No.	Dyestuff dispersion	Heat treatment before dispersion	Heat treatment after dispersion *)	Desensitization degree
20 1 (comparative)	None	-	-	0.03
2 (")	I-1-A	No	No	0.16
25 3 (")	I-1-B	No	"	0.15
4 (present	I-1-C	Yes	"	0.07
5 (")	I-1-D	"	"	0.05
30 6 (")	I-1-E	"	"	0.03
7 (")	I-1-F	"	"	0.03
35 8 (")	I-1-A	No	Yes	0.03
9 (")	I-1-D	Yes	"	0.03
40 10 (")	I-1-E	"	"	0.03

*) Heat treatment after dispersion

An aqueous dispersion with a dyestuff concentration of 2 % was heat-treated with stirring at a temperature of 85 °C for 6 hours.

Table 1 shows that the specimens which had not been heat-treated (Specimen Nos. 2 and 3) exhibit a great desensitization degree after storage while the specimens which had been heat-treated (Specimen Nos. 4 to 10) exhibit little desensitization after storage. This shows that heat treatment is effective for the enhancement of the storage stability of the photographic light-sensitive material. It is also shown in Table 1 that these specimens, which had been heat-treated in the presence of an organic compound containing a carboxylic group (Specimen Nos. 6 to 10), exhibit an enhanced storage stability.

It is further shown in Table 1 that the specimens which had comprised a solid fine dispersion of Dyestuff I-1 incorporated therein (Specimen Nos. 2 to 10) exhibit an excellent sharpness and less residual color after processing than the specimen which had not comprised the solid fine dispersion incorporated therein.

EXAMPLE 2

Dispersion was effected in the same manner as in Example 1 except that Dyestuff I-1 was replaced by the dyestuffs set forth in Table 2. Using the dispersions which were heat-treated at a temperature of 85 °C for 6 hours or not heat-treated, silver halide photographic materials were prepared in the same manner as in Example 1. These specimens were then measured for densensitization degree after storage at 40 °C and 80 % RH for 3 days. The results are set forth in Table 2.

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Table 2

5	Specimen No.	Dyestuff	Heat treatment	Desensitization
	11 (comparative)	I-2	No	0.16
10	12 (present invention)	"	Yes	0.03
	13 (comparative)	I-3	No	0.17
15	14 (present invention)	"	Yes	0.04
	15 (comparative)	I-5	No	0.15
20	16 (present invention)	"	Yes	0.03
	17 (comparative)	I-7	No	0.16
25	18 (present invention)	"	Yes	0.03
	19 (comparative)	I-8	No	0.15
30	20 (present invention)	"	Yes	0.03
	21 (comparative)	I-10	No	0.15
35	22 (present invention)	"	Yes	0.03
	23 (comparative)	I-16	No	0.17
40	24 (present invention)	"	Yes	0.03
	25 (comparative)	I-20	No	0.14
45	26 (present invention)	"	Yes	0.03
	27 (comparative)	I-21	No	0.17
50	28 (present invention)	"	Yes	0.04

Table 2 (continued)

	<u>Specimen No.</u>	<u>Dyestuff</u>	<u>Heat treatment</u>	<u>Desensitization</u>
5	29 (comparative)	I-22	No	0.16
10	30 (present invention)	"	Yes	0.04
	31 (comparative)	I-23	No	0.18
15	32 (present invention)	"	Yes	0.04
	33 (comparative)	I-24	No	0.16
20	34 (present invention)	"	Yes	0.05
	35 (comparative)	I-25	No	0.17
25	36 (present invention)	"	Yes	0.04
	37 (comparative)	I-26	No	0.15
30	38 (present invention)	"	Yes	0.04
	39 (comparative)	I-28	No	0.20
35	40 (present invention)	"	Yes	0.04
	41 (comparative)	I-31	No	0.16
40	42 (present invention)	"	Yes	0.05
	43 (comparative)	I-33	No	0.17
45	44 (present invention)	"	Yes	0.05

Table 2 shows that even oxonol dyestuffs of the present invention other than Dyestuff I-1 can also be heat-treated to provide solid fine dispersions which do not deteriorate photographic properties.

50 EXAMPLE 3

To a mixture of 26.2 g of 1-(4-carboxyphenyl)-3-methyl-2-pyrazoline-5-one, 14.2 g of glutaconaldehydedianil hydrochloride and 200 ml of N,N-dimethylformamide was added 30.3 g of triethylamine. The mixture was then stirred at room temperature for 1 hour. To the reaction solution was added 100 ml of methanol. The reaction solution was subjected to dust removal by filtration. To the material was added dropwise a methanol solution of hydrochloric acid (mixture of 53 ml of a 36 % concentrated hydrochloric acid and 80 ml of methanol) with stirring at a temperature of 20 °C to 25 °C in 15 minutes. After the dropwise addition, the material was further stirred at the same temperature for 30 minutes. The reaction

product was filtered off with suction, and then washed with 200 ml of methanol three times. The reaction product was then washed with water until the filtrate became neutral. Thus, 83 g of Dyestuff I-1 (hereinafter referred to as Dyestuff (IV)) was obtained in a wet state (content of Dyestuff (IV): 28.5 %).

60 g of Dyestuff (IV) in a wet state was dried by blowing air at room temperature for 1 week. After being dried, the material weighed 17.1 g. This product will be hereinafter referred to as "Dyestuff IV-1".

60 g of Dyestuff (IV) in a wet state was heat-dried at a temperature of 60 °C to 70 °C at normal pressure for 3 days. After being dried, the material weighed 17.1 g. This product will be hereinafter referred to as "Dyestuff IV-2".

To 10 g of Dyestuff IV-1 was added 60 ml of water. The reaction system was heated under reflux for 8 hours. The reaction system was cooled to room temperature. The resulting solid content was filtered off with suction. 25 g of Dyestuff (IV) which had been heat-treated was obtained in a wet state (content of Dyestuff (IV): 40 %). This product will be hereinafter referred to as "Dyestuff IV-3".

To 10 g of Dyestuff IV-1 was added 40 ml of acetic acid. The reaction system was heated under reflux at a temperature of 105 to 110 °C for 7 hours. The reaction system was cooled to room temperature. The resulting solid content was filtered with suction. The solid content thus obtained was washed with 100 ml of methanol once and then with 50 ml of water four times to obtain 18 g of heat-treated Dyestuff (IV) in a wet state (content of Dyestuff (IV): 55.6 %). This product will be hereinafter referred to as "Dyestuff IV-4".

To 10 g of Dyestuff IV-1 was added 100 ml of a 1 % aqueous solution of carboxymethyl cellulose. The reaction system was heated under reflux for 8 hours. The reaction system was cooled to room temperature to obtain an aqueous suspension. This product will be hereinafter referred to as "Dyestuff IV-5".

EXAMPLE 4

The dyestuff powders prepared in Example 3 (the dyestuffs in the form of a wet suspension were dried at room temperature) were lightly ground in an agate mortar and then applied to an X-ray diffraction measuring holder. The specimens were then measured by a Rotor Flex Diffractometer (manufactured by Rikagaku Denki K.K.) at a diffraction angle 2θ of 5 ° to 60 °.

Typical diffraction charts thus obtained are shown in Figs. 1 and 2. Although there is some deviation, three definite peaks are observed with the oxonol dyestuff at about 7 °, about 14 ° and about 26 ° to 27 °. The ratio of the intensity of primary diffraction at a diffraction angle 2θ of about 26 to 27 degree to that of secondary diffraction at a diffraction angle 2θ of about 14 degree is set forth in Table 3. The dyestuffs prepared according to the synthesis method of the present invention exhibits as small a diffraction intensity ratio as 1.30 or less. Unlike the comparative specimens prepared according to the conventional synthesis method, the dyestuffs of the present invention showed a quite unexpected change.

Table 3

Dyestuff	Diffraction intensity at diffraction angle 2θ of about 26 to 27 degree	
	Diffraction intensity at diffraction angle 2θ of about 14 degree	
IV-1	1.44	
IV-2	1.20	
IV-3	1.07	
IV-4	0.72	
IV-5	0.91	

EXAMPLE 5Preparation of Dispersion A (comparative)

5 A dispersion was prepared in accordance with Example 1 in JP-A-52-92716. Specifically, to 50 g of Dyestuff IV-1 were added 1.34 g of sodium oleyl methyl tauride as a dispersant and a small amount of water to obtain a premix. Water was added to the premix to make 500 g. The material was then subjected to dispersion with Ottawa sand as a dispersant by a sand grinder for 4 hours. After dispersion, the material was diluted with water to prepare Dispersion A with a dyestuff concentration of 2 %.

Preparation of Dispersion B (comparative)

10 A dispersion was prepared in accordance with an example in WO 88/04794. Specifically, to 20 g of Dyestuff IV-1 were added 72 ml of a 5 % aqueous solution of Triton X-200^R (available from Rohm & Haas) as a dispersant. To the mixture was added water to make 500 g. The material was then subjected to dispersion with zirconia beads by an oscillating ball mill for 10 hours. After being dispersed, the material was diluted with water to prepare Dispersion B with a dyestuff concentration of 2 %.

Preparation of Dispersions C to E (according to the present invention)

20 A dispersion was prepared in accordance with Example 1. Specifically, to 3.75 g of Dyestuff IV-2 was added 37.5 ml of a 1 % aqueous solution of carboxymethyl cellulose to prepare a premix. To the premix was added 53.7 ml of water. The material was then subjected to dispersion with zirconia beads by a horizontal medium dispersing machine (Eiger Motor Mill M-50, manufactured by Eiger Japan Co. Ltd.) for 3 hours. The dispersion was then diluted with water to obtain Dispersion C with a dyestuff concentration of 2 %.

Dyestuff IV-3 was similarly dispersed to prepare Dispersion D.

Dyestuff IV-4 was similarly dispersed with the dyestuff solid concentration corrected to prepare Dispersion E.

Preparation of Dispersion F (according to the present invention)

30 Dyestuff suspension IV-5, which had been obtained according to heat treatment in Example 3, was all subjected to dispersion in the same manner as Dispersion C by an Eiger Motor Mill for 3 hours. After dispersed, the dispersion was diluted to obtain Dispersion F.

Preparation of Dispersions G and H (according to the present invention)

40 Dispersions A and E were each partially measured out. These dispersions were each stored at a temperature of 85 °C for 6 hours. The heated dispersions will be hereinafter referred to as "Dispersions G and H".

Preparation of Dispersion I (according to the present invention)

45 200 ml of Dispersion F was prepared and then subjected to high frequency processing in a household microwave oven available from Toshiba Corporation for 2 minutes. The dispersion will be hereinafter referred to as "Dispersion I".

EXAMPLE 6Preparation of coat film specimens 4-1 to 4-9

50 On a 180- μ m gelatin-undercoated polyethylene terephthalate support were coated the following components to prepare coat films:

Gelatin	4.0 g/m ²
Dispersion of Dyestuff (IV)	70 mg/m ² (in terms of solid content of dyestuff)
Potassium polystyrenesulfonate	25 mg/m ²
Sodium dodecylbenzenesulfonate	10 mg/m ²
1,2-Bis(vinylsulfonylacetamide)ethane	80 mg/m ²

The specimens comprising Dispersions A to I will be hereinafter referred to as "coat film specimens 4-1 to 4-9", respectively.

Preparation of coat film specimen 4-10

A coating solution comprising Dispersion F and excluding 1,2-bis(vinylsulfonylacetamide)ethane as a film hardener was stored at a temperature of 70 °C for 16 hours. To the material was then added the film hardener. A film was then prepared from this coating solution in the same manner as the coat film specimen 4-1 to obtain a coating film specimen 4-10.

EXAMPLE 7

Measurement of spectral absorpton spectrum

A fresh batch of the coat film specimens 4-1 to 4-10 prepared in Example 4 were measured for spectral absorption spectrum. Another batch of these specimens were stored under heat and moisture conditions of 50 °C and 80 % RH for 3 days before the measurement of spectral absorption spectrum. The measurement was effected at a wavelength of 360 nm to 800 nm by means of a Type U-3210 spectrophotometer available from Hitachi, Ltd.

It was found that different dispersions exhibit quite different absorbances at 530 nm and 680 nm even though they contain the same compound. It was also found that the specimens which had been stored under wet conditions exhibit a reduced absorbance at 680 nm and an increased absorbance at 630 nm. This proves that heat and moisture can accelerate the dissociation of some dyestuffs.

Table 4 provides the absorbance of the fresh specimens at 530 nm and 680 nm and the ratio of the absorbance of these specimens at 680 nm to that at 530 nm, and the change in the absorbance at 630 nm of these specimens after storage under wet conditions.

Table 4

Coat film No.	Dispersion	Dyestuff	Fresh absorbance			Δ Abs 630 (Wet - Fresh)
			530nm	680nm	680nm 530nm	
4-1(comparative)	A	IV-1	0.451	0.358	0.793	0.167
4-2(")	B	IV-1	0.428	0.400	0.934	0.207
4-3(present invention)	C	IV-2	0.504	0.218	0.433	0.080
4-4(")	D	IV-3	0.511	0.205	0.401	0.074
4-5(")	E	IV-4	0.585	0.175	0.299	0.048
4-6(")	F	IV-5	0.565	0.178	0.315	0.057
4-7(")	G	IV-1	0.472	0.223	0.472	0.103
4-8(")	H	IV-4	0.571	0.142	0.249	0.013
4-9(")	I	IV-5	0.559	0.148	0.265	0.022
4-10(") F(coating heated)		IV-5	0.562	0.154	0.274	0.035

Judging from the fact that they exhibit almost the same absorption spectrum as that shown in the absorption spectrum graph described in JP-A-52-92716, the coated film specimens 4-1 and 4-2, which have been prepared by the comparative synthesis and dispersion methods, are considered to be known dispersions of Dyestuff (IV). It can be seen that these known dispersions exhibit a relatively high absorbance at 680 nm and a big absorbance change after storage under wet conditions, whereas the dispersions according to the present invention exhibit a relatively low absorbance at 680 nm and a small absorbance change after storage under wet conditions.

EXAMPLE 8

In order to examine the properties of these dispersions in the photographic light-sensitive materials, the following silver halide emulsions were prepared.

Preparation of raw emulsion # 1

Solution I (75 °C)	
Deashed inert gelatin	24 g
Distilled water	90 ml
KBr	4 g
KI	1.7 g
10 % Aqueous solution of phosphoric acid	2 ml
Sodium benzenesulfinate	5×10^{-2} mol
1,3-Dimethylimidazolidine-2-thione	2.5×10^{-3} g

Solution II (35 °C)	
Silver nitrate	170 g
Distilled water to make	1,000 ml

Solution III (35 °C)	
KBr	230 g
0.001 % Aqueous solution of potassium hexachloroiridiumate (III)	2 ml
Distilled water to make	1,000 ml

Solution IV (room temperature)	
Potassium hexacyanoferricyanate (II)	3.0 g
Distilled water to make	100 ml

To Solution I were simultaneously added Solution II and Solution III with vigorous stirring in 45 minutes. When Solution II was entirely added to the system, a monodisperse emulsion of cubic grains having an average grain diameter of 0.28 μm was eventually obtained.

In this procedure, the rate at which Solution III is added to the system was adjusted with respect to the addition of Solution II such that the pAg value of the mixture was kept at 7.50. Solution IV was added to the system at 5 minutes from 7 minutes after the beginning of the addition of Solution II. After the completion of the addition of Solution II, sedimentation was immediately conducted for washing and desalting. The emulsion was then dispersed in an aqueous solution containing 100 g of deashed inert gelatin. To the emulsion were then added sodium thiosulfate and chloroauric acid tetrahydrate in an amount of 34 mg per mol of silver each so that the pH value and pAg value of the system were adjusted to 7.0 and 8.9 (40 °C), respectively. To the emulsion were then added 5 mg of sodium thiosulfate, 3 mg of N,N-dimethylthiourea and 10 mg of chloroauric acid. The emulsion was then subjected to chemical sensitization at a temperature of 75 °C for 60 minutes to obtain a surface latent image type silver halide emulsion. To this emulsion were added 50 mg of 2-methyl-4-hydroxy-1,3,3a,7-tetrazaindene and 100 ppm of phenoxyethanol as stabilizers.

On a 100- μm thick polyethylene terephthalate (PET) support which had been previously corona-discharged on the surface thereof to enhance the adhesion to a hydrophilic colloidal layer was coated a first subbing layer comprising a styrene-butadiene latex. On the first subbing layer was then coated a second subbing layer comprising gelatin in an amount of 0.08 g/m². On the second subbing layer were then coated an antihalation layer, an emulsion layer, and a protective layer in sequence as mentioned below to prepare light-sensitive sheets 1 to 11.

light-sensitive sheet 1

Antihalation layer	
Gelatin	1,500 mg/m ²
Dispersion A	120 mg/m ² (in terms of Dyestuff (IV))
Potassium polystyrenesulfonate	30 mg/m ²
Sodium dodecylbenzenesulfonate	8 mg/m ²
Proxel	15 mg/m ²
1,2-Bis(vinylsulfonylacetamide)ethane	65 mg/m ²

The coating solution thus prepared was adjusted with a 2 % aqueous solution of phosphoric acid to pH 5.6 before coating.

Emulsion layer

Silver halide emulsion

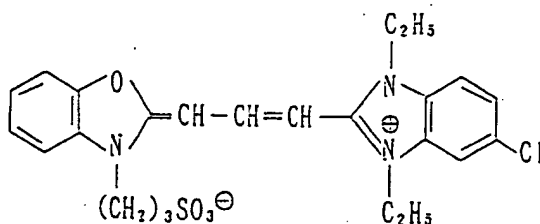
1,500 mg/m²

(in terms of silver)

1,550 mg/m²

(in terms of gelatin)

Sensitizing dye

21 mg/m²

5-Methylbenzotriazole

3.6 mg/m²

Sodium dodecylbenzenesulfonate

4.4 mg/m²

Potassium polystyrenesulfonate

30 mg/m²

Polyethyl acrylate latex

200 mg/m²

(in terms of solid

content)

1,2-Bis(vinylsulfonylacetamide)ethane

66 mg/m²

The coating solution thus prepared was adjusted with a 2 % aqueous solution of phosphoric acid to pH 5.8 before coating.

Protective layer	
Gelatin	500 mg/m ²
Colloidal silica	100 mg/m ²
Liquid paraffin	23 mg/m ²
Barium strontium sulfate (average grain diameter: 1.5 μm)	13 mg/m ²
Proxel	2 mg/m ²
N-perfluorooctanesulfonyl-N-propylglycine potassium	2 mg/m ²
C ₉ H ₁₉ -(C ₆ H ₄)-O-{CH ₂ CH(OH)CH ₂ O} ₇ H	6 mg/m ²
1,2-Bis(vinylsulfonylacetamide)ethane	22 mg/m ²

The coating solution thus prepared exhibited a pH value of 6.4.

To the light-sensitive sheet thus prepared was added dropwise 20 μl of distilled water. After 1 minute at a temperature of 25 °C, the light-sensitive sheet exhibited a pH value of 6.1 when measured by means of a surface electrode.

Light-sensitive sheets 2 to 9

Light-sensitive sheets 2 to 9 were prepared in the same manner as the light-sensitive sheet 1 except that Disperion A to be incorporated in the antihalation layer was replaced by Dispersions B to I (content of
 5 Dyestuff (IV): 120 mg/m²), respectively.

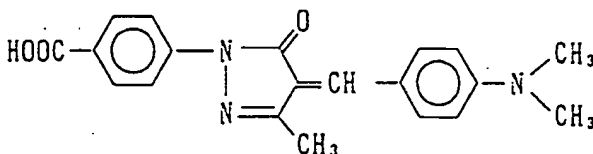
Light-sensitive sheet 10

Light-sensitive sheet 10 was prepared in the same manner as the light-sensitive sheet 1 except that the
 10 composition of the antihalation layer was altered as follows:

Antihalation layer	
Gelatin	1,500 mg/m ²
Dispersion E	80 mg/m ² (in terms of Dyestuff (IV))
Dispersion J	100 mg/m ² (in terms of Dyestuff (A))
Potassium polystyrenesulfonate	30 mg/m ²
Potassium dodecylbenzenesulfonate	8 mg/m ²
Proxel	15 mg/m ²
1,2-Bis(vinylsulfonylacetamide)ethane	65 mg/m ²

The coating solution thus prepared was adjusted with a 2 % aqueous solution of phosphoric acid to pH
 5.6 before coating.

Dispersion J was prepared from a powdered form of Dyestuff (A) shown below in the same manner as
 25 Dispersion B.

Light-sensitive sheet 11

A comparative light-sensitive sheet was prepared as light-sensitive sheet 11 in the same manner as the
 light-sensitive sheet 1 except that the antihalation layer excluded the dyestuff dispersion.

These light-sensitive sheets were gradationwise exposed to light through a continuous wedge, and then
 40 subjected to negative development. Another batch of these light-sensitive sheets was subjected to forced
 heat and moisture test at a temperature of 40 °C and a relative humidity of 80 % for 3 days before
 exposure and development.

Negative development

The negative development was conducted with a commercially available microfilm processing solution
 (FR-537 developer available from FR Chemicals, U.S.) by means of a Type F-10 deep tank automatic
 developing machine available from Allen Products, U.S. under the following conditions:

Step	Processing solution	Temperature	Time
1. Development	FR-537 (1 : 3)	30 °C	60 sec.
2. Washing	Running water	--	"
3. Fixing	FR-535 (1 : 3)	30 °C	"
4. Washing	Running water + spray	--	120 sec.
5. Drying	Heated air	60 °C	60 sec.

The developed specimens were measured by means of a densitometer. Table 5 shows the sensitivity change at a density of 1.2 after the forced age test with respect to the fresh sensitivity.

Table 5

<u>Light-sensitive sheet No.</u>	<u>Dispersion</u>	<u>Sensitivity change</u>
1	A (comparative)	- 0.26
2	B (")	- 0.28
3	C (present invention)	- 0.14
4	D (")	- 0.10
5	E (")	- 0.05
6	F (")	- 0.07
7	G (")	- 0.16
8	H (")	- 0.02
9	I (")	- 0.03
10	E, J (")	- 0.04
11	-- (comparative)	+ 0.02

It can be seen that the light-sensitive sheets according to the present invention exhibit a sensitivity drop after storage under heat and moisture conditions as compared with the blank test (light-sensitive sheet 11) but exhibit a drastic improvement as compared with the comparative examples having a great ratio of the absorbance at 680 nm.

EXAMPLE 9

Preparation of light-sensitive sheet 7-1

A 175- μ m thick biaxially oriented blue-dyed polyethylene terephthalate film was subjected to corona discharge treatment. On both sides of the polyethylene terephthalate film was coated a hydrophobic polymer layer having the following composition in the following amount by means of a wire bar coater. The coat material was dried at a temperature of 175 °C for 1 minute.

(Hydrophobic polymer layer)	
Butadiene-styrene copolymer latex (butadiene/styrene weight ratio = 31/69)	0.322 g/m ²
2,4-Dichloro-6-hydroxy-s-triazine sodium	4.2 mg/m ²

On the hydrophobic polymer layer was then coated a hydrophilic colloidal layer having the following composition in the following amount by means of a wire bar coater. The coat material was then dried at a temperature of 150 °C for 1 minute.

(2nd subbing layer: hydrophilic colloidal layer)	
Gelatin	80 mg/m ²
Polyethyl acrylate	20 mg/m ²
Dispersion H	11 mg/m ² (in terms of Dyestuff (IV))
C ₁₂ H ₂₅ O(CH ₂ CH ₂ O) ₁₀ H	4 mg/m ²
Proxel	0.3 mg/m ²

On both sides of the coat material were coated a silver halide emulsion layer and a surface protective layer in accordance with the emulsion preparation and coating method as described in Example 1 of JP-A-2-264936. The amount of the emulsion layer and the surface protective layer coated per one side of the coat material were as follows:

Emulsion layer	
Coated amount of silver	1.9 g/m ²
Coated amount of gelatin	1.2 g/m ²

Surface protective layer

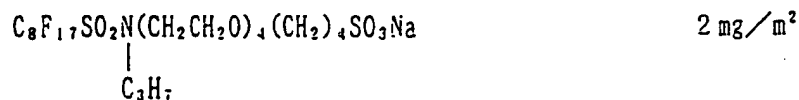
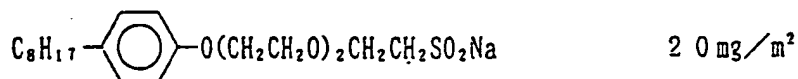
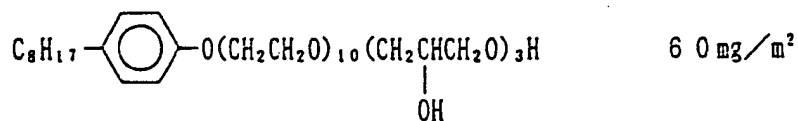
Gelatin 0.61 g/m²

Dextran (average molecular weight:
39,000) 0.61 g/m²

Sodium polyacrylate (average molecular
weight: 41,000) 70 mg/m²

Matting agent (average grain diameter:
3.5 μm)

9 : 1 Copolymer of polymethyl
methacrylate and methacrylic acid 0.06 g/m²



4-Hydroxy-6-methyl-1,3,3a,7-tetrazaindene

15.5 mg/m²

As a film hardener, 1,2-bis(sulfonylacetamide)ethane was coated in an amount of 56 mg/m² per one side.

Preparation of light-sensitive sheet 7-2

Light-sensitive sheet 7-2 was prepared in the same manner as the light-sensitive sheet 7-1 except that Dispersion H to be incorporated in the 2nd subbing layer was replaced by Dispersion B.

Preparation of light-sensitive sheet 7-3

A blank light-sensitive sheet 7-3 was prepared in the same manner as the light-sensitive sheet 7-1 except that the 2nd subbing layer was free of Dispersion H.

Evaluation of photographic properties

A fresh batch of these light-sensitive sheets were prepared. Another batch of these light-sensitive sheets were stored under the conditions of 50 °C and 68 % RH for 5 days. These light-sensitive sheets were each sandwiched between HR-4 screen available from Fuji Photo Film Co., Ltd. and a black paper in close contact, exposed to X-ray through a water phantom (10 cm), and then subjected to the following processing steps.

Development	35 °C x 6.3 sec.
Fixing	31 °C x 6.7 sec.
Squeeze	15 °C x 4 sec.
Drying	60 °C x 8 sec.
Dry-to-dry processing time 29 sec.	

The developer and fixing solution used had the following compositions:

Developer	
Potassium hydroxide	29 g
Potassium sulfite	44.2 g
Sodium hydrogencarbonate	7.5 g
Boric acid	1.0 g
Diethylene glycol	12 g
Ethylenediaminetetraacetic acid	1.7 g
5-Methylbenzotriazole	0.06 g
Hydroquinone	25 g
Glacial acetic acid	18 g
Triethylene glycol	12 g
5-Nitroindazole	0.25 g
1-Phenyl-3-pyrazolidoneglutaraldehyde (50 wt/wt %)	9.86 g
Sodium metabisulfite	12.6 g
Potassium bromide	3.7 g
Water to make	1.0 l

Fixing solution	
Ammonium thiosulfate (70 wt/vol %)	200 ml
Disodium ethylenediaminetetraacetate dihydrate	0.02 g
Sodium sulfite	15 g
Boric acid	10 g
Sodium hydroxide	6.7 g
Glacial acetic acid	15 g
Aluminum sulfate	10 g
36 N sulfuric acid	3.9 g
Water to make	1 l
pH	4.25

After processing, the emulsion layer was completely removed from the specimens on the side which had been in close contact with the black paper. The specimens were then subjected to sensitometry to determine fog and sensitivity at a density of (fog density + 0.5).

The results as tabulated in Table 6 show that the dyestuff dispersions according to the present invention provide a high sensitivity under fresh conditions and a small sensitivity drop and an small fog increase after storage under heat and moisture conditions. All these results are close to those obtained in the blank test. The synthesis methods which have heretofore been known probably make the dyestuff easily diffusable into the emulsion layer, causing a sensitivity drop and fog increase. Thus, the superior effects of the present invention can be readily seen.

Table 6

Light-sensitive sheet No.	Relative sensitivity ($S_{0.5}$)			Fog		
	Fresh	50 ° C68%RH	Change	Fresh	50 ° C68%RH	Change
7-1 (present invention)	1.36	1.29	-0.07	0.176	0.185	+0.009
7-2 (comparative)	1.33	1.15	-0.18	0.189	0.219	+0.030
7-3 (comparative blank)	1.38	1.34	-0.04	0.173	0.179	+0.006

EXAMPLE 10

Preparation of Specimen 801

On a 127- μ m thick undercoated cellulose triacetate film were coated various layers having the following compositions to prepare a multi-layer color photographic light-sensitive material as Specimen 801. The figure indicates the added amount per m². The effects of the compounds added are not limited to their description.

1st layer: antihalation layer	
Black colloidal layer	0.20 g
Gelatin	1.9 g
Ultraviolet absorbent U-1	0.1 g
Ultraviolet absorbent U-3	0.04 g
Ultraviolet absorbent U-4	0.1 g
High boiling organic solvent Oil-1	0.1 g
Solid fine dispersion of Dyestuff E-1 (added in the form of Dispersion B of Dyestuff IV of the present invention)	0.1 g

2nd layer: interlayer	
Gelatin	0.40
Compound Cpd-C	5 mg
Compound Cpd-J	5 mg
Compound Cpd-K	3 mg
High boiling organic solvent Oil-3	0.1 g
Dyestuff D-4	0.4 mg
Emulsion D	0.4 g (in terms of silver)
Gelatin	1.1 g
Coupler C-1	0.3 g
Coupler C-2	0.1 g
Coupler C-3	0.7 g
Additive P-1	0.1 g

7th layer: interlayer	
Gelatin	0.6 g
Additive M-1	0.3 g
Color stain inhibitor Cpd-1	2.6 mg
Ultraviolet absorbent U-1	0.01 g
Ultraviolet absorbent U-2	0.002 g
Ultraviolet absorbent U-5	0.01 g
Dyestuff D-1	0.02 g
Dyestuff D-5	0.02 g
Compound Cpd-C	5 mg
Compound Cpd-J	5 mg
Compound Cpd-K	5 mg
High boiling organic solvent Oil-1	0.02 g

8th layer: interlayer	
Exteriorly and internally-fogged silver bromiodide emulsion (average grain diameter: 0.06 μ m; fluctuation coefficient: 16 %; AgI content: 0.3 mol %)	0.02 g (in terms of silver)
Gelatin	1.0 g
Additive P-1	0.2 g
Color stain inhibitor Cpd-A	0.1 g

9th layer: low sensitivity green-sensitive emulsion layer

Emulsion E	0.1 g (in terms of silver)
Emulsion F	0.2 g (in terms of silver)
Emulsion G	0.2 g (in terms of silver)
Gelatin	0.5 g
Coupler C-4	0.1 g
Coupler C-7	0.05 g
Coupler C-8	0.20 g
Compound Cpd-B	0.03 g
Compound Cpd-C	10 mg
Compound Cpd-D	0.02 g
Compound Cpd-E	0.02 g
Compound Cpd-F	0.02 g
Compound Cpd-G	0.02 g
Compound Cpd-L	0.05 g
High boiling organic solvent Oil-1	0.1 g
High boiling organic solvent Oil-2	0.1 g

10th layer: middle sensitivity green-sensitive emulsion layer

Emulsion G	0.3 g (in terms of silver)
Emulsion H	0.1 g (in terms of silver)
Gelatin	0.6 g
Coupler C-4	0.1 g
Coupler C-7	0.2 g
Coupler C-8	0.1 g
Compound Cpd-B	0.03 g
Compound Cpd-D	0.02 g
Compound Cpd-E	0.02 g
Compound Cpd-F	0.05 g
Compound Cpd-G	0.05 g
Compound Cpd-L	0.05 g
High boiling organic solvent Oil-2	0.01 g

11th layer: high sensitivity green-sensitive emulsion layer

Emulsion I	0.5 g (in terms of silver)
Gelatin	1.0 g
Coupler C-4	0.3 g
Coupler C-7	0.1 g
Coupler C-8	0.1 g
Compound Cpd-B	0.08 g
Compound Cpd-C	5 mg
Compound Cpd-D	0.02 g
Compound Cpd-E	0.02 g
Compound Cpd-F	0.02 g
Compound Cpd-G	0.02 g
Compound Cpd-J	5 mg
Compound Cpd-K	5 mg
Compound Cpd-L	0.05 g
High boiling organic solvent Oil-1	0.02 g
High boiling organic solvent Oil-2	0.02 g

12th layer: interlayer	
Gelatin	0.6 g

13th layer: yellow filter layer	
Yellow colloidal silver	0.07 g (in terms of silver)
Gelatin	1.1 g
Color stain inhibitor Cpd-A	0.01 g
High boiling organic solvent Oil-1	0.01 g
Solid fine dispersion of Dyestuff E-2	0.05 g

14th layer: interlayer	
Gelatin	0.6 g

15th layer: low sensitivity blue-sensitive emulsion layer	
Emulsion J	0.2 g (in terms of silver)
Emulsion K	0.3 g (in terms of silver)
Emulsion L	0.1 g (in terms of silver)
Gelatin	0.8 g
Coupler C-5	0.2 g
Coupler C-6	0.1 g
Coupler C-10	0.4 g

16th layer: middle sensitivity blue-sensitive emulsion layer	
Emulsion L	0.1 g (in terms of silver)
Emulsion M	0.4 g (in terms of silver)
Gelatin	0.9 g
Coupler C-5	0.3 g
Coupler C-6	0.1 g
Coupler C-10	0.1 g

17th layer: high sensitivity blue-sensitive emulsion layer	
Emulsion N	0.4 g (in terms of silver)
Gelatin	1.2 g
Coupler C-5	0.1 g
Coupler C-6	0.1 g
Coupler C-10	0.6 g
High boiling organic solvent Oil-2	0.1 g

18th layer: 1st protective layer	
Gelatin	0.7 g
Ultraviolet absorbent U-1	0.2 g
Ultraviolet absorbent U-2	0.05 g
Ultraviolet absorbent U-5	0.3 g
Formalin scavenger Cpd-H	0.4 g
Dyestuff D-1	0.1 g
Dyestuff D-2	0.05 g
Dyestuff D-3	0.1 g

19th layer: 2nd protective layer	
Colloidal silver	0.1 mg (in terms of silver)
Emulsion of finely divided silver bromiodide grains (average grain diameter: 0.06 μm ; AgI content: 1 mol %)	0.1 g (in terms of silver)
Gelatin	0.4 g

20th layer: 3rd protective layer	
Gelatin	0.4 g
Polymethyl methacrylate (average grain diameter: 1.5 μm)	0.1 g
4 : 6 Copolymer of methyl methacrylate and acrylic acid (average grain diameter: 1.5 μm)	0.1 g
Silicone oil	0.03 g
Surface active agent W-1	3.0 mg
Surface active agent W-2	0.03 g

Besides the above mentioned compositions, additives F-1 to F-8 were incorporated in all the emulsion layers. Besides the above mentioned compositions, to each of the various layers were added a gelatin hardener H-1, and coating and emulsifying surface active agents W-3, W-4, W-5 and W-6.

Further, as preservatives and mildewproofing agents there were added phenol, 1,2-benzisothiazoline-3-one, 2-phenoxyethanol, phenethyl alcohol, and p-benzoic butyl ester.

The silver iodobromide emulsions used for Specimen 801 are as follows.

<u>Emulsion</u>	<u>Character- istic of grains</u>	<u>Average grain size correspond- ing to a circle</u> (μm)	<u>Floculation coefficient</u> (%)	<u>Content of AgI</u> (%)
5	A monodisperse tetradecahedral grain	0.28	16	3.7
10	B monodisperse cubic inner-latent type grain	0.30	10	3.3
15	C monodisperse tabular grain mean aspect ratio 4.0	0.38	18	5.0
20	D tabular grain mean aspect ratio 8.0	0.68	15	2.0
25	E monodisperse cubic grain	0.20	17	4.0
30	F monodisperse cubic grain	0.23	16	4.0
35	G monodisperse cubic inner-latent type grain	0.28	11	3.5
40				
45				
50				
55				

5	H	monodisperse cubic inner-latent type grain	0.32	9	3.5
	I	tabular grain mean aspect ratio 8.0	0.80	28	1.5
10	J	monodisperse tetradecahedral grain	0.30	18	4.0
	K	monodisperse tabular grain mean aspect ratio 7.0	0.45	17	4.0
15	L	monodisperse cubic inner-latent type grain	0.46	14	3.5
20	M	monodisperse tabular grain mean aspect ratio 10.0	0.55	13	4.0
25	N	tabular grain mean aspect ratio 12.0	1.00	33	1.3

Spectral Sensitization of Emulsions A to N

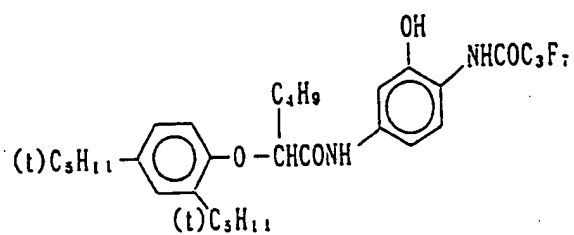
30	<u>Emulsion</u>	<u>Added sensitizing dye</u>	<u>Added amount per mole of silver halide (g)</u>
	A	S-2	0.025
35		S-3	0.25
		S-8	0.01
	B	S-1	0.01
		S-3	0.25
40		S-8	0.01
	C	S-1	0.01
		S-2	0.01
		S-3	0.25
45		S-8	0.01
	D	S-2	0.01
		S-3	0.10
		S-8	0.01
50	E	S-4	0.5
		S-5	0.1

55

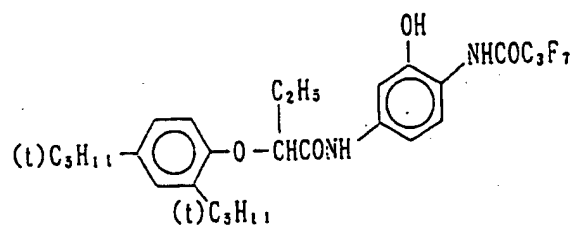
EP 0 554 834 A2

	F	S-4	0.3
		S-5	0.1
5	G	S-4	0.25
		S-5	0.08
		S-9	0.05
10			
	H	S-4	0.2
		S-5	0.06
		S-9	0.05
15			
	I	S-4	0.3
		S-5	0.07
	J	S-9	0.1
20		S-7	0.2
		S-6	0.05
	K	S-6	0.2
		S-5	0.05
25			
	L	S-6	0.22
		S-5	0.06
	M	S-6	0.15
30		S-5	0.04
	N	S-6	0.22
		S-5	0.06
35			
40			
45			
50			
55			

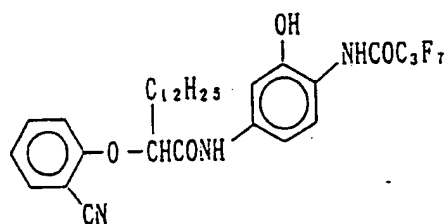
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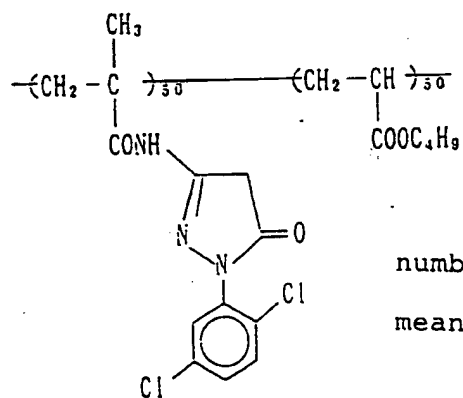
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C - 3



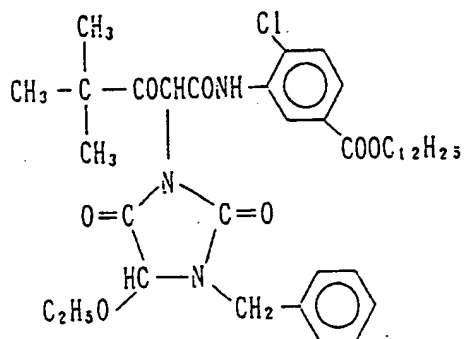
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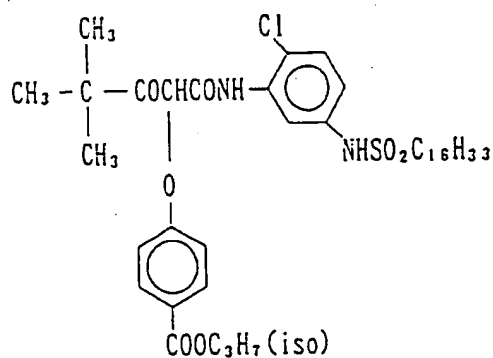
number : % by weight

mean molecular weight :
about 25,000

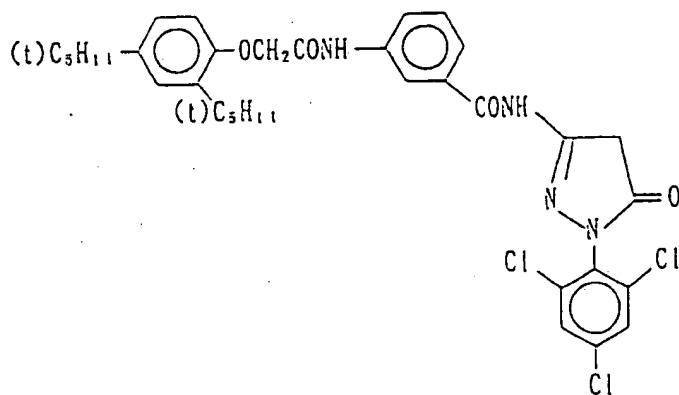
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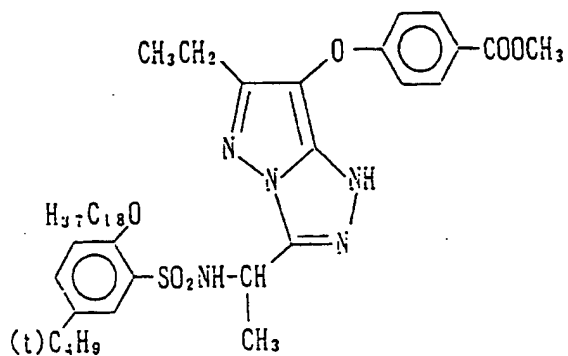
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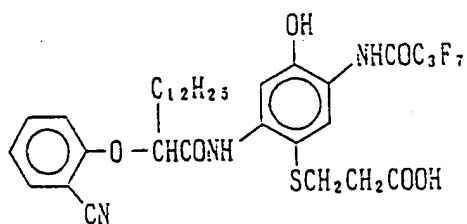
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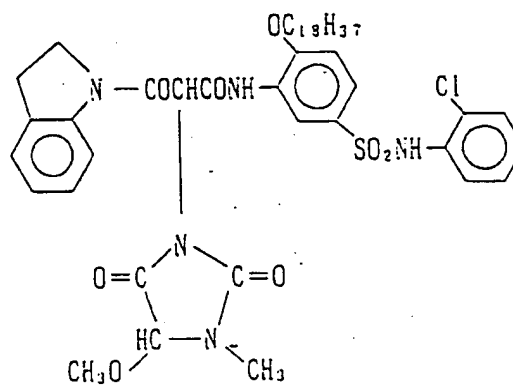
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C - 9



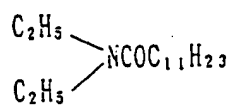
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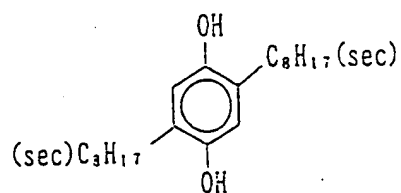
Oil-1 Dibutyl phthalate

Oil-2 Tricersyl phosphate

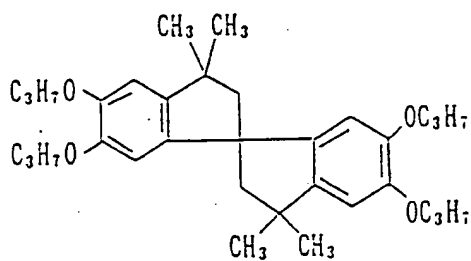
Oil-3



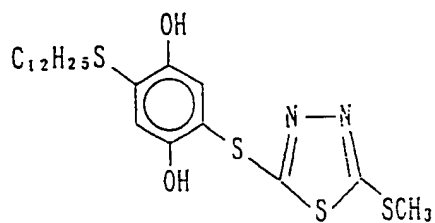
Cpd-A



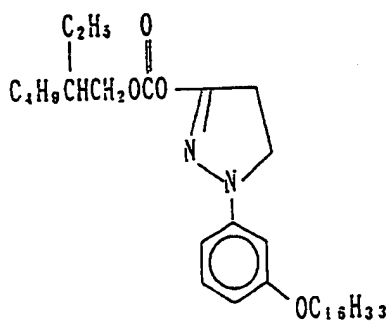
Cpd-B



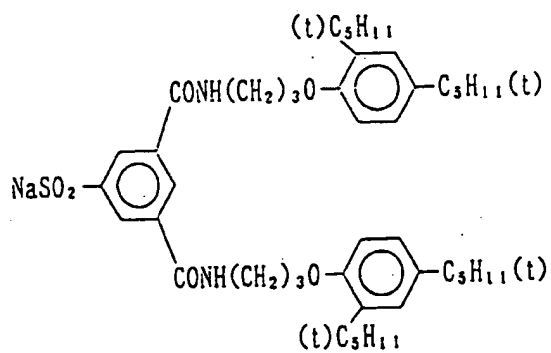
Cpd-C



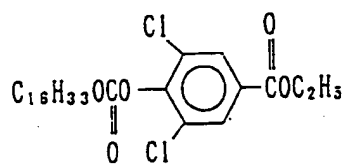
Cpd - D



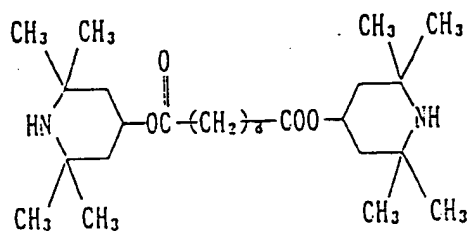
Cpd - E



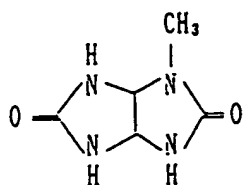
Cpd - F



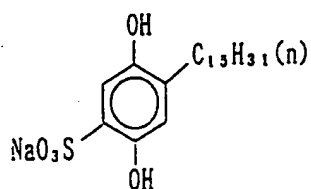
Cpd - G



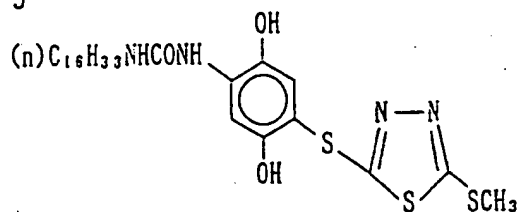
Cpd-H



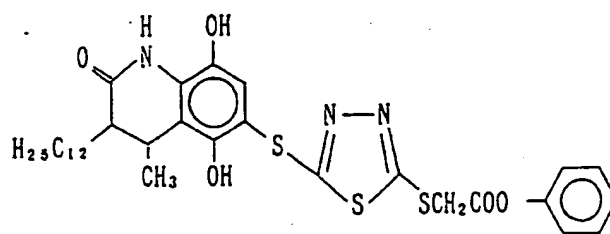
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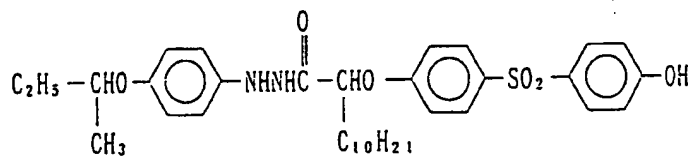
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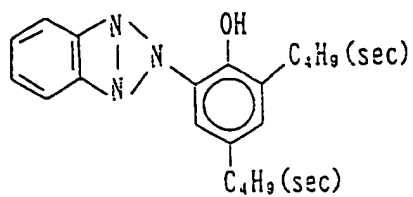
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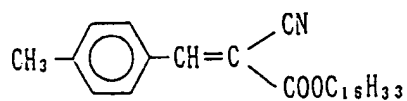
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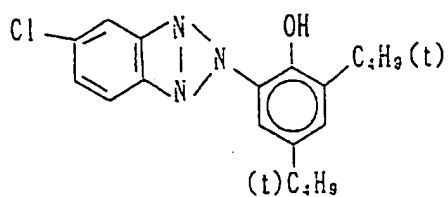
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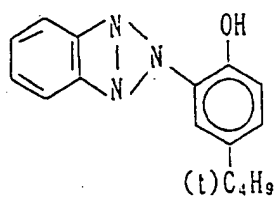
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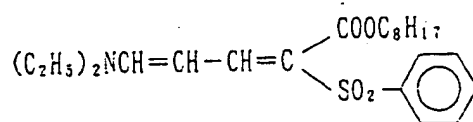
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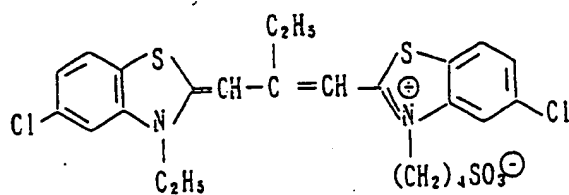
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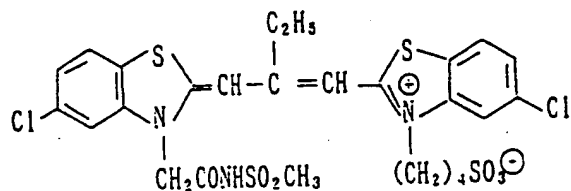
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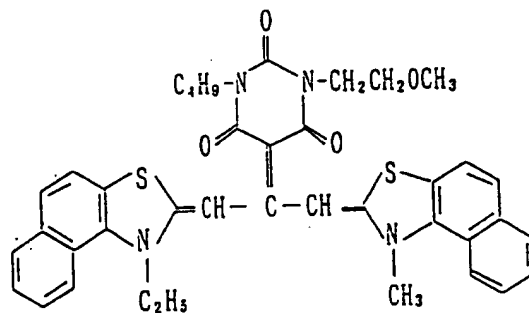
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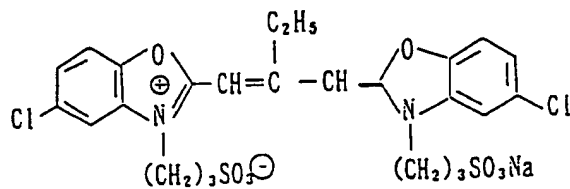
S - 2



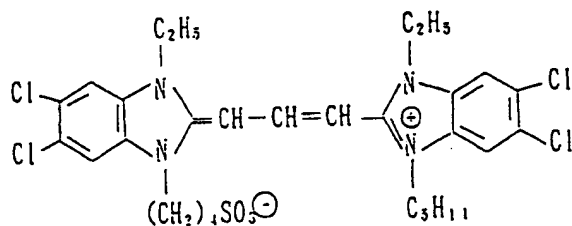
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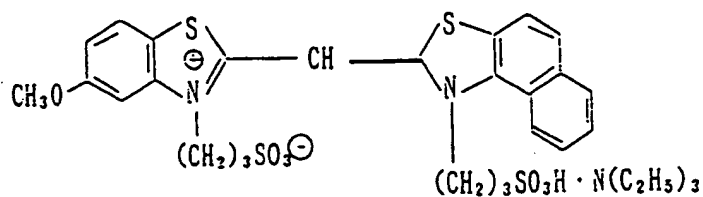
S - 4



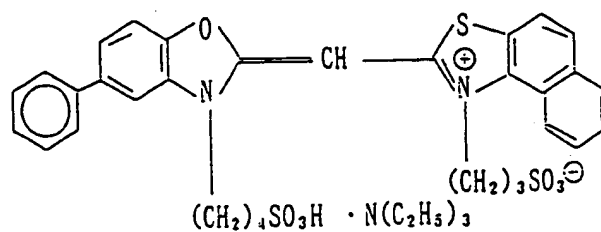
S - 5



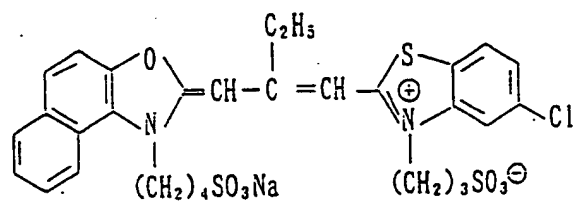
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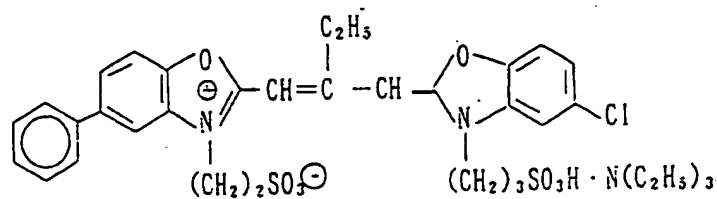
S - 7



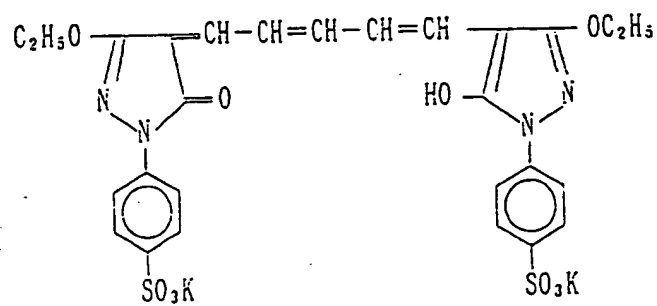
S - 8



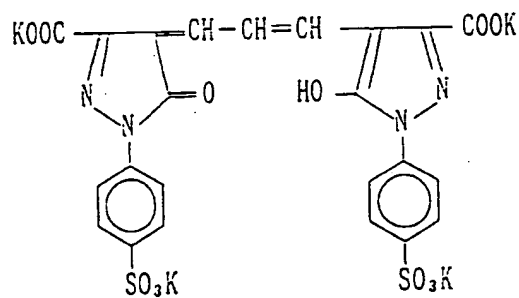
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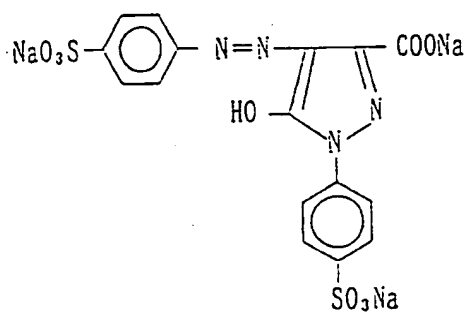
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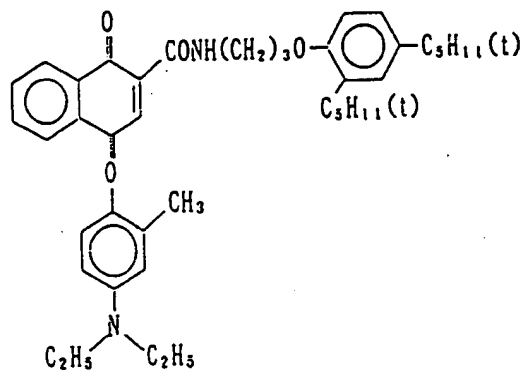
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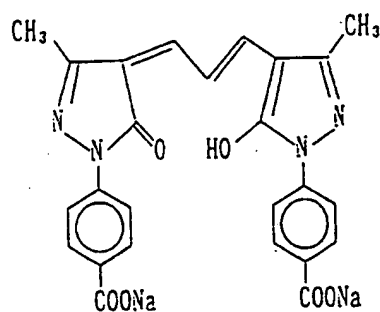
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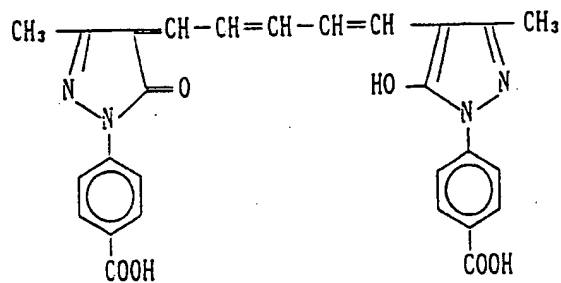
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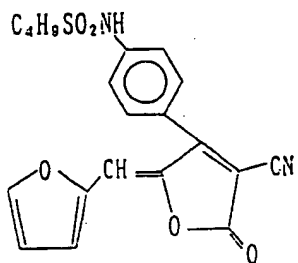
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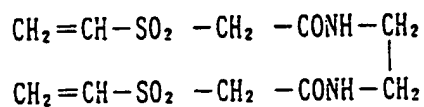
E-1 (Dyestuff (IV) of the present invention)



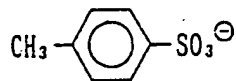
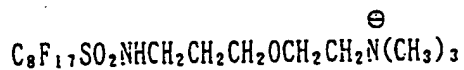
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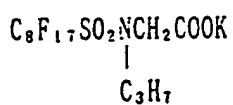
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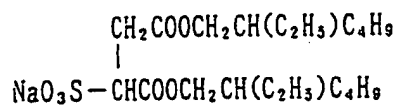
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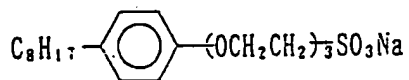
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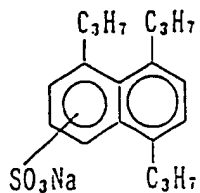
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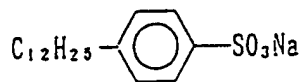
W-4



W-5



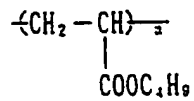
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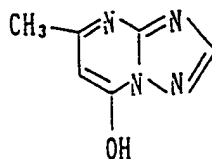
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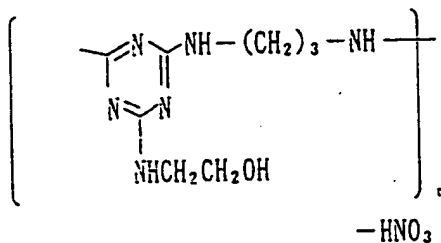
M - 1



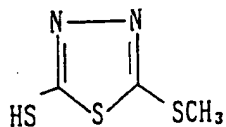
F - 1



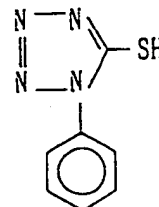
F - 2



F - 3



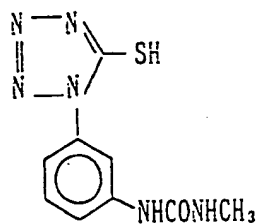
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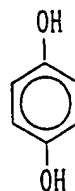
F - 5

F - 6

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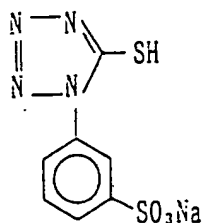


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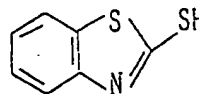
F - 7

F - 8

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A multi-layer color light-sensitive material was prepared as Specimen 802 in the same manner as Specimen 801 except that Dyestuff E-1 to be incorporated in the 1st antihalation layer was replaced by Dispersion H of Dyestuff IV of the present invention.

The silver halide color photographic material specimens thus prepared were exposed to light, and then processed in the following steps:

Processing step	Time	Temperature
1st Development	6 min.	38 °C
Washing	2 min.	38 °C
Reversal	2 min.	38 °C
Color development	6 min.	38 °C
Adjustment	2 min.	38 °C
Bleach	6 min.	38 °C
Fixing	4 min.	38 °C
Washing	4 min.	38 °C
Stabilization	1 min.	25 °C

The various processing solutions had the following compositions:

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1st Developer	
Pentasodium nitrilo-N,N,N-trimethylenephosphonic acid	1.5 g
Pentasodium diethylenetriaminepentaacetate	2.0 g
Sodium sulfite	30 g
Hydroquinone potassium monosulfonate	20 g
Potassium carbonate	15 g
Sodium bicarbonate	12 g
1-Phenyl-4-methyl-4-hydroxymethyl-3-pyrazolidone	1.5 g
Potassium bromide	2.5 g
Potassium thiocyanate	1.2 g
Potassium iodide	2.0 mg
Diethylene glycol	13 g
Water to make	1,000 ml
pH (adjusted with hydrochloric acid or potassium hydroxide)	9.60

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Reversing solution	
Pentasodium nitrilo-N,N,N-trimethylenephosphonic acid	3.0 g
Stannous chloride dihydrate	1.0 g
p-Aminophenol	0.1 g
Sodium hydroxide	8 g
Glacial acetic acid	15 ml
Water to make	1,000 ml
pH (adjusted with hydrochloric acid or potassium hydroxide)	6.00

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Color developer	
Pentasodium nitrilo-N,N,N-trimethylenephosphonic acid	2.0 g
Sodium sulfite	7.0 g
Trisodium phosphate dodecahydrate	36 g
Potassium bromide	1.0 g
Potassium iodide	90 mg
Sodium hydroxide	3.0 g
Citrazinic acid	1.5 g
N-ethyl-N-(β -methanesulfonamideethyl)-3-methyl-4-aminoaniline 3/2 sulfate monohydrate	11 g
3,6-Dithiaoctane-1,8-diol	1.0 g
Water to make	1,000 ml
pH (adjusted with hydrochloric acid or potassium hydroxide)	11.80

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Adjustor	
Disodium ethylenediaminetetraacetate dihydrate	8.0 g
Sodium sulfite	12 g
1-Thioglycerol	0.4 g
Formaldehyde-sodium bisulfite adduct	30 g
Water to make	1,000 ml
pH (adjusted with hydrochloric acid or sodium hydroxide)	6.20

Bleaching solution	
Disodium ethylenediaminetetraacetate dihydrate	2.0 g
Ferric ammonium ethylenediaminetetraacetate dihydrate	120 g
Potassium bromide	100 g
Ammonium nitrate	10 g
Water to make	1,000 ml
pH (adjusted with hydrochloric acid or sodium hydroxide)	5.70

Fixing solution	
Ammonium thiosulfate	80 g
Sodium sulfite	5.0 g
Sodium bisulfite	5.0 g
Water to make	1,000 ml
pH (adjusted with hydrochloric acid or aqueous ammonia)	6.60

Stabilizer	
Benzoisothiazoline-3-one	0.02 g
Polyoxyethylene-p-monononylphenylether (average polymerization degree: 10)	0.3 g
Water to make	1,000 ml
pH	7.0

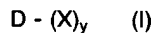
A fresh batch of Specimens 801 and 802 and another batch of these specimens which had been stored at a temperature of 50 °C and 80 % RH for 3 days were exposed to light, processed, and then measured for density to evaluate the change in red sensitivity.

Specimen 801 which had been stored under heat and moisture conditions exhibited a sensitivity drop of 0.20 with respect to the fresh batch while Specimen 802, which comprises the dispersion of the present invention, exhibited a sensitivity drop of 0.05 with respect to the fresh batch. Thus, remarkable improvements were obtained.

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

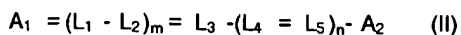
Claims

1. A process for the dispersion of a dyestuff represented by the following formula (I), which comprises accelerating molecular orientation in advance and/or during the dispersion and/or after the dispersion:



wherein D represents a compound containing chromophores; X represents a dissociative proton or dissociative proton-containing group connected to D directly or via a divalent connecting group; and y represents an integer 1 to 7.

2. A process for the dispersion of a dyestuff according to Claim 1, wherein dyestuff is an oxonol dyestuff, formula (I) is represented by the following formula (II) and said acceleration of molecular orientation is carried out by heating:

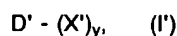


wherein A_1 and A_2 each represents an acidic nucleus necessary for the formation of an oxonol dyestuff; L_1 , L_2 , L_3 , L_4 and L_5 each represents a substituted or unsubstituted methine group; and m and n each represents an integer 0 or 1.

3. A dispersion process according to Claim 2, wherein said heating is effected in the presence of an organic compound containing carboxylic group.

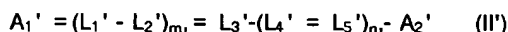
4. A dispersion process according to Claim 2, wherein A_1 and A_2 in formula (II) each is a pyrazolone nucleus.

5. A silver halide photographic material, which comprises a dyestuff represented by formula (I') being dispersed therein by the acceleration of molecular orientation in advance and/or during dispersion and/or after dispersion:



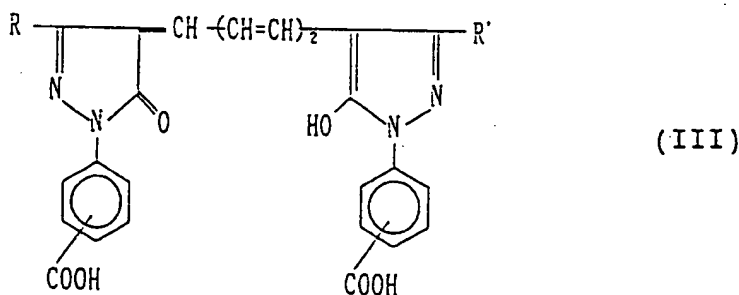
wherein D' represents a compound containing chromophores; X' represents a dissociative proton or dissociative proton-containing group connected to D' directly or via a divalent connecting group; and y' represents an integer 1 to 7.

6. A silver halide photographic material according to Claim 5 comprising on a support at least one light-sensitive silver halide emulsion layer and at least one hydrophilic colloidal layer containing a solid dispersion of dyestuff, said dyestuff is represented by formula (II') and the ratio of the absorbance at 680 nm to that at 530 nm in the absorption spectrum of said dyestuff is in the range of 0.50 or less:



wherein A_1' and A_2' each represents an acidic nucleus necessary for the formation of an oxonol dyestuff; L_1' , L_2' , L_3' , L_4' and L_5' each represents a substituted or unsubstituted methine group; and m' and n' each represents 0 or 1.

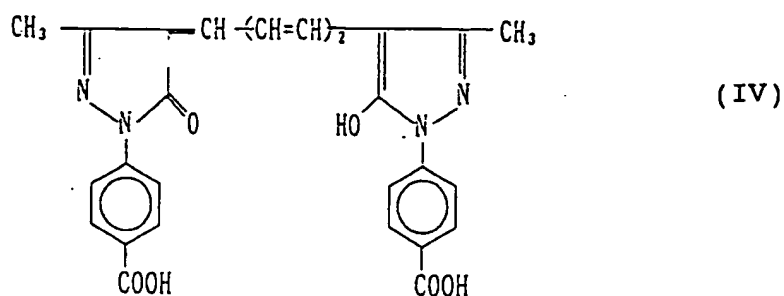
7. A silver halide photographic material according to Claim 6, wherein said dyestuff is represented by the following formula (III):



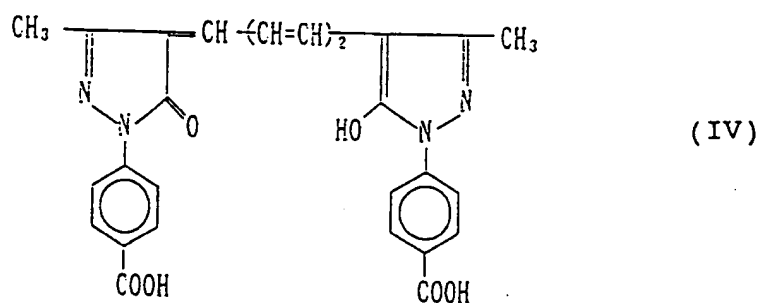
wherein R and R' each represents a substituted or unsubstituted alkyl group, a substituted or unsubstituted aryl group or an ester group.

8. A silver halide photographic material according to Claim 6 wherein the ratio of the primary diffraction intensity when the diffraction angle 2θ of X-ray diffraction of said dyestuff is about 26 to 27 degrees to the secondary diffraction intensity when the diffraction angle 2θ is about 14 degrees is 1.30 or less.

9. A silver halide photographic material according to Claim 7, wherein said dyestuff is represented by the following formula (IV):



- 15 10. A silver halide photographic material according to Claim 8, wherein said dyestuff is represented by the following formula (IV):



- 30 11. A silver halide photographic material according to Claim 6, wherein said hydrophilic colloidal layer containing a solid dispersion of dyestuff is present between said support and said silver halide emulsion layer.

- 35 12. A silver halide photographic material according to Claim 11, wherein the coated amount of said hydrophilic colloid in the hydrophilic colloidal layer containing a solid dispersion of dyestuff is in the range of 0.5 g/m² or less per one side of the support.

Fig. 1

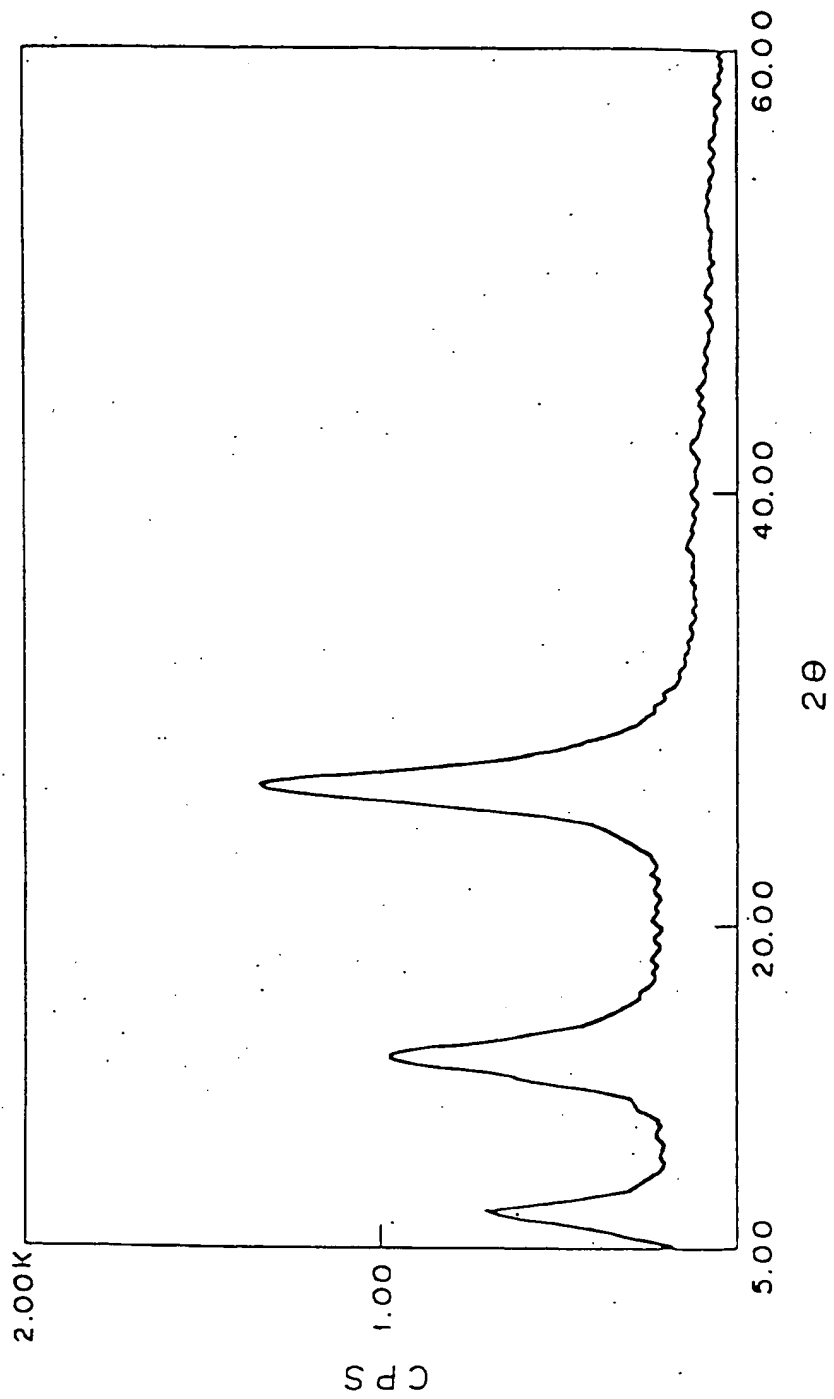


Fig. 2

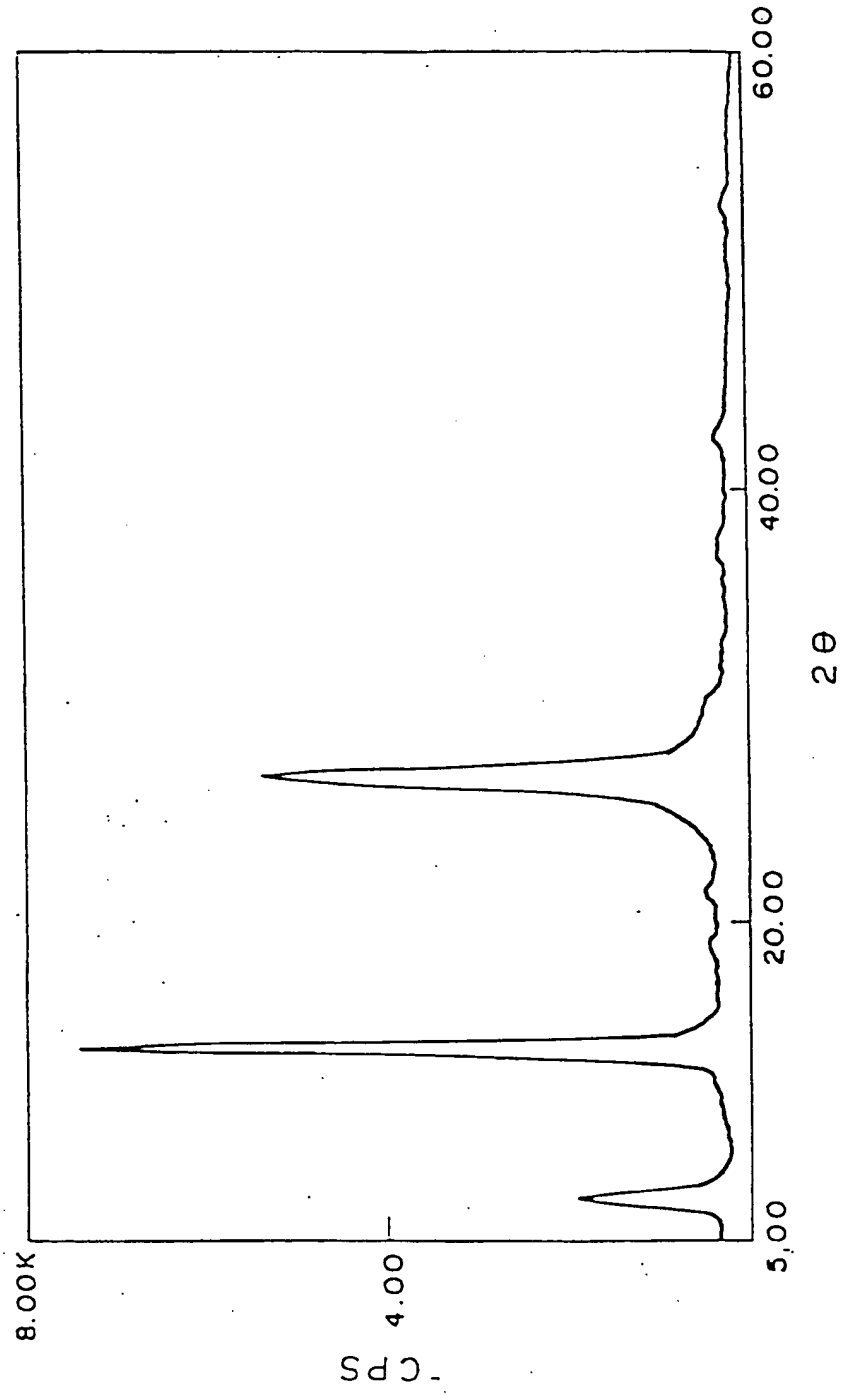


Fig. 3